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AMERICAN ENGINEER AND RAILROAD JOURNAL.

Formerly the RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, JULY, 1895.

EDITORIAL NOTES.

THE usual discussion regarding the interchange rules was *the* discussion at the Master Car-builders' Convention, to the almost total exclusion of the other topics. As was to be expected, the Chicago agreement came in for its full share of attention, but its adoption was wisely postponed for serious consideration for another year. As we have already noted, the present rules seem to be crippled by their own weight and the almost utter impossibility of securing a uniform interpretation. Still they are working, and all hands are more or less familiar with them, so that it would not be advisable to step in with an innovation that would upset the existing order until that innovation has been more thoroughly tested than has been possible during the few months that the Chicago agreement has been in force. By another year the parties in favor of and opposed to the agreement will have been able to martial their forces, and we may look for some warm work when the subject is again thrown open for discussion.

THERE was some opposition to increasing the weight of cars at the Master Car-builders' Convention, on the ground of the great extra expense entailed in hauling. This was placed at one-half a cent per ton mile; so that, if one ton were added to each of five cars composing a train running 200 miles a day, the cost for extra haulage would be $5 a day, or approximately $1800 a year. The inaccuracy of this is so manifest that it seems strange that it was not detected on the spot. The one-half cent covers *all* expenses, and in this connection might be considered as fixed charges, while the extra cost of hauling is limited to the extra amount of coal burned, oil used, and wear, the latter being so small that it can be neglected. Taking the coal at 2½ oz. per ton mile, 156.25 lbs. represents the extra coal consumption per day, which, with coal at $2 a ton, would cost a trifle less than 16 cents, or about $48 a year. Fifty dollars would, on this basis, cover all *extra* expenses, provided, of course, that the existing engines would not have to be enlarged in order to haul this extra five tons.

CONVENTIONS.

FOR some reasons, which it is now not worth while to analyze, June has been selected as the season for holding engineering conventions. This year the Master Car-builders' Association led off on June 11 at Thousand Islands, and was followed a week later by the Master Mechanics at the same place. The Civil Engineers also met at that time in the Hotel Pemberton in Boston Harbor. The Mechanical Engineers assembled in Detroit on June 25, and the International Railway Congress met in London on June 26.

A very common inquiry by persons who are not familiar with the objects and proceedings of these meetings is, What are they for? A question which is answered by different people in different ways. Some persons who are not much interested in technical subjects would say that their object is that the members and others who attend them may have an outing and a good time; others would say that their chief purpose is to afford an opportunity to those who attend them for social intercourse. The Constitution of the Master Car-builders' Association says:

"The objects of this Association shall be the advancement of knowledge concerning the construction, repair, and service of railroad cars, by discussions in common, investigations and reports of the experience of its members; to provide an organization through which the members and the companies they represent may agree upon such joint action as may be required to bring about uniformity and interchangeability on the parts of railroad cars, to improve their construction and to adjust the mutual interests growing out of their interchange and repair."

The Constitution of the Master Mechanics' Association has substantially the same provision and statement of objects.

The objects of the Society of Civil Engineers is defined to be:

"The advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members.

"Among the means to be employed for this purpose shall be meetings for the presentation and discussion of appropriate papers and for social and professional intercourse."

What the Mechanical Engineers' Society aims to accomplish is, as formulated in its "Rules:"

"To promote the Arts and Sciences connected with Engineering and Mechanical Construction by means of meetings for social intercourse and the reading and discussion of professional papers."

In seeking to accomplish these avowed objects, each of these associations holds at least one annual meeting, which is attended by from 500 to 1,000 people, who devote from one to ten days' time thereto. The average expenses for attendance of members in all probability is not less than $50, and the cost for printing, reporting, and other expenses incidental to the holding of the meetings will amount to fully $5,000 apiece, so that the actual cost in money of holding each of these meetings must be somewhere from $30,000 to $55,000. If, in addition to these amounts, we charge $10 per day as the average value of the time of those in attendance, this cost would be more than doubled. With that of entertainments of various kinds, it will probably be quite within reasonable limits to say that the annual expense of holding the four meetings referred to must be somewhere from $500,000 to $1,000,000. The London meeting will be much more costly than any of the American assemblages on account of the larger number of people who will be in attendance, the greater distance they must travel, and the time consumed to attend it.

It is, therefore, worth considering whether this large expenditure of money is as productive of the results aimed at as it could be made, or, in other words, it may be asked whether

we are getting the full worth of the expenditure; and if not what should be done to increase the usefulness and the profit of such organizations?

The problem may be stated somewhat as follows: Several hundreds of people engaged in kindred engineering occupations come together annually for deliberation on subjects in which they are mutually interested, and with reference to which each one has had experience and knowledge of his own which differs more or less from that of all the others. *Problem:* How to extract the maximum amount of information from those who have it for the benefit of those who have it not.

The solution will require some investigation into the philosophy and practice of deliberative or, as Jefferson called them, "considerative" bodies.

Now, what is a deliberative body and what is it organized for? "Deliberation," the dictionary tells us, is "the act of weighing or examining, or the careful discussion of the reasons for and against a choice or measure." A deliberative body is based on the fact that all people see things differently. Dr. Holmes said that it was a mistake to assume that there were only two sides to every question, and observed that all subjects were at least hexagonal. We are all too apt to feel and assume that our view of any matter is the only one which any person can rationally have. Experience teaches us that there is an infinity of ways of regarding all topics which are presented to the human consciousness; and if we are wise we learn that much practical wisdom can be elicited by the free presentation, comparison, and discussion of varying opposing and divergent views, theories, facts and measures. The prime intent and aim of a deliberative body, therefore, is that it should be a *talking* body; and, as Carlyle said, "Speech is the gaseous element out of which most kinds of practice and performance . . . condense themselves and take shape; *as the one is, so will the other be.*" In view of the time, thought and money which are annually devoted to the meetings under consideration, if it be true, as Carlyle indicated, that as the talk at these meeting is, so will be the subsequent practice and performance of those who attend them, it is of very great importance that the very best talk should be obtained that is possible. It must be kept in mind that the fountains of talk, the sources of knowledge and wisdom which supply the stream that flows from these meetings, are in the minds of the members who compose the associations. The members must be taken as they are, with their training, experience and education (or lack of them). If all of them could have had the advantages of a liberal education, or if it were possible to unscrew some of their heads and readjust the impalpable mechanism of their brains, so as to quicken their powers of observation, correct the lenses of their minds through which they see things strabismatically, readjust the gearing of their logical mills so that they would grind out only reasonable inferences and conclusions, doubtless their deliberations would be immensely improved. Unfortunately our heads are not removable excepting with disastrous results, and when the bearings of our minds become worn we can't put in new "brasses," and it is difficult even to lubricate them if they once get hot. All that can be done is to get the best we can out of the members of the associations as they are.

They meet together for the ostensible purpose of advancing or increasing knowledge of the subjects in which they are all interested. Varying degrees and kinds of knowledge is dispersed among these individuals, is unequally diffused among them on account of the infinitely varied causes which have influenced their intellectual development. The problem, then, evidently is to collect from all those who meet together the most valuable knowledge of which they are each possessed and weigh it or subject it to a kind of intellectual assay to determine its value. In other words, it is required to extract from a somewhat miscellaneous lot of ore the grains and the lumps of pure metal which it may contain. To carry our analogy a little farther, each member of these conventions, it may be supposed, brings his "kibble" of intellectual ore to the meeting, and the purpose should be to extract as much precious metal therefrom as possible. Now, how can this be done?

It has been said that the object of a deliberative body is to call out and *hear* talk. The word hear is italicized in order to call attention to its literal meaning, for the reason that after an experience of 25 years in attending conventions it has been observed that at most of them it has not been possible to *hear*. This has been due to bad acoustic properties of the rooms in which the meetings were held, the bad arrangement of the seats in relation to the chairman and his satellites, and to outside noises and disturbances. The members travel hundreds—some of them thousands—of miles and devote days or weeks of time and expend considerable money in order to talk for perhaps a few minutes and to listen for many hours, and when they reach their destination they find that the main purpose for which they have come has been to a very considerable extent defeated by one or more or all of the causes enumerated. The cure for these evils is, first, care in the selection of a hall. This should not be too large, as there are seldom more than 250 persons present at any of the meetings. Second, there should be a committee appointed to take charge of the meetings, part of whose duty should be to see that all disturbing noises, both within and without the meeting-room, are suppressed. The chairman's platform and the seats should be arranged in such a way that the former would occupy a central position in relation to the latter, and so that the seats should face the chairman in front and on each side of him. If this had been done in the "opera house" at Alexandria Bay it would have enabled many of those present to hear, who, as it was, could get only a confused idea of what was going on. This feature of the meetings is worthy of attention too, because hearing has a reflex action on the mind and stimulates those who hear well to speak, whereas if the listeners get only a vague and confused idea of the proceedings their mental energy is consumed by the effort to hear, and they have not enough left to stimulate them to talk. It can constantly be seen that, owing to inability to hear, members grow tired and leave the meeting-room, and the "proceedings interest them no more." If the usefulness of a convention under the most favorable circumstances is represented by 100, that usefulness would be diminished at least 33⅓ per cent. if the members cannot hear what is going on.

But some one has said, "There are many who talk on from ignorance rather than from knowledge, and who find the former an inexhaustible fund of conversation." This is true, probably, of all deliberative bodies. The wind-bag we have always with us. He is irrepressible. All that we can hope to do is to reduce his dimensions as much as possible; but inasmuch as he is gaseous by nature, he will always expand and fill any space he is permitted to occupy. Our only hope is to limit his time. There is a beneficence about the laws of human thought and expression which affords a sort of refuge from ignorance and fatuity. It is the fact that wisdom and knowledge can generally be expressed briefly, whereas the length and depth and breadth of folly or *nescience* requires much time to unwind itself. The obvious thing to do, then, is to limit the time of speakers. If this is done, those who have anything which is much worth hearing will generally be able to say it, while the fountains of folly will be shut off. The difficulty generally is to find a chairman who is sufficiently ruthless to enforce the time limit rigidly. To meet this difficulty, some one has proposed a mechanism for the protection of deliberative bodies from blatherskites. It was to consist of a small platform on which each speaker must stand when he addresses his audience. Over this platform a pail of water is to be suspended on trunnions. Clock-work is connected with the pail

and the platform, so that when the speaker steps on the latter it will wind up the horological mechanism so as to run just five or 10 minutes, and then—tip the pail.

No intellectual sieve has ever been devised for a deliberative body which will let the wind-bags through, and will retain only those speakers who are most worth listening to. It would be an unspeakable blessing if some such discovery could be made. Until such an invention is perfected, reliance must be placed on the chairman of the meetings. Much depends upon him. If he has the discrimination to know who are the men best worth listening to, he can do much to encourage them to speak and to call them out at the proper times.

Most of our readers are familiar with the system of appointing committees of investigation to report on various subjects of interest to the two railroad associations referred to in the beginning of this article. The same system has been adopted by the International Railway Congress. A common complaint which has been made is that the circulars of inquiry which are sent out by committees are answered by comparatively few persons to whom they are sent. This fact and the other consideration that printed or written questions are very much less effective in educing information than oral inquiries are, leads to the suggestion that committees of investigation of the various associations might with advantage call such members as are supposed to have some special or valuable knowledge relating to the subjects of investigation to appear before them during the sessions of the conventions, to give testimony and be questioned in relation to such subjects. The advantages of oral and cross examinations are shown daily in our courts of justice. Of course the appearance before such committees and the answering of questions would only be voluntary, as the associations have no authority to compel any one to appear or to answer. If, for example, a committee on water-tube boilers should invite persons who have been using such boilers to appear before them, while the convention was in session—or at other times—and should question them with reference to the performance, defects and advantages of such boilers, it would be quite sure to result in the collection of a great deal of very valuable information which probably could not be obtained otherwise. Of course the party appearing could decline to answer any inquiries he might not want to answer. If a committee on compound locomotives could have invited a dozen members of the Master Mechanics' Association to appear before them, and could, by skilful questioning, have elicited from them the results of their experience during the past few years, it would have enabled such a committee to get information which it is next to impossible to get otherwise, and which it is utterly hopeless to expect will come in response to a printed circular of inquiry. With this privilege a committee could select the men to appear before them who are known to have the information desired, the intelligence to discern that which is important from that which is not, and who would be sufficiently independent to give their testimony without fear or favor.

Some months ago we commented on the summary manner in which discussions were often ended in these associations by persons who are not interested in the subject moving—just as the audience was warming up to the debate—that the discussion be closed. The matter was referred to by Mr. Lentz, the President of the Master Car-builders' Association, in his annual address, in which he said:

"In order that there may be a full discussion on all questions that may be brought before the convention, I propose and ask for your consent to depart from the usual custom of parliamentary practice to this extent; when a motion is made to close the discussion, I ask the privilege of ascertaining for the information of the members if any one still wishes to talk further on the subject, and I would recommend an amendment to the by-laws providing for this change in practice."

Such an amendment, we learn, was adopted, and this particular form of gag is not likely to be applied to discussions in this association hereafter.

There is one other topic that ought to be referred to before this long article is ended—that is, the importance of brevity in the proceedings of our associations. There are now so many of them, and they are turning out such quantities of "proceedings" that it is impossible for busy men to do more than skim over it. Our plea is, give us the best of everything, but let it be short as possible.

TWO NOTABLE LOCOMOTIVES.

In the last number of the AMERICAN ENGINEER we gave illustrations and a description of a locomotive built at the Baldwin Locomotive Works for the Concord & Montreal Railroad. In this number we give similar illustrations of another engine for the same kind of traffic and for the same road, but built by the Schenectady Locomotive Works. The one illustrated last month, it will be remembered, was a 10-wheeled engine of a design which has not yet been extensively introduced into this country, but of a type which is common on the continent of Europe. The Schenectady engine, on the other hand, is of the ordinary American type, with four driving-wheels and a four-wheeled truck. As these engines are for the same line and to be used in the same traffic, a comparison of their performance and merits will be possible and will be interesting. Both of these machines are admirable specimens of the art of locomotive-building, and their performance will be watched with much interest. To facilitate comparison, the weight and dimensions of each are printed in parallel columns.

The writer confesses to a predilection for a design of locomotive similar to that which the Baldwin Works have adopted. A concession, however, had to be made by them to the impression that a four-wheeled leading truck is essential for safety in a high-speed engine. This makes it difficult to get all the advantages which would result from this general plan if it was somewhat modified. It will be remembered that the *Columbia*, which the Baldwin Company exhibited at Chicago, had a leading truck with a single pair of wheels in front. With this arrangement and by moving the driving-wheels about a foot farther forward, the fire-box would be entirely behind the back pair. If a pair of trailing wheels of 36 in. in diameter were substituted instead of the 50 in. wheels which were used, the fire-box could then be made as wide as might be desired, and therefore shorter than it was in the engine for the Concord road.

We have quoted a number of times in these pages a paper written about two or more years ago by Frederick Siemens, in which he showed that whenever flame came in contact with any solid substance combustion was partially arrested, and that in all furnaces we should aim to keep the flame out of contact with their sides until the process of combustion is completed. The inference from this was that a sphere would be the ideal form for a furnace, and in fact that is approximately the shape adopted in the ordinary egg-shaped stoves for burning bituminous coal. But as a sphere would not be a convenient form for a locomotive fire-box, and as a cube is the closest approximation thereto that existing shapes will admit of, the inference is that it might be well to make locomotive furnaces of such dimensions that their height, length and breadth would all be equal. This would be possible with a locomotive of a design similar to the *Columbia*, and it is believed would make a very efficient engine. The plan permits the driving-wheels to be placed as close together as the flanges of their wheels will allow. The coupling-rods may therefore be correspondingly shortened. These wheels being under the middle of the engine, they can be loaded with as much or as little weight as may be desired, and a liberal length of tube would be provided.

The performance of these two engines will be watched with a great deal of interest, and we will endeavor to keep our readers informed of what they are doing. They are each excellent examples of the latest American practice.

NEW PUBLICATIONS.

THE MECHANICAL ENGINEER'S POCKET-BOOK. *A Reference Book of Rules, Tables, Data and Formulæ, for the Use of Engineers, Mechanics and Students.* By William Kent. New York: John Wiley & Sons. 1087 pp., 4 × 6½ in., $5.00.

Current engineering literature is beginning to fill the minds of many engineers with dismay. Thirty or forty years ago, when many of us started in our careers, an assiduous student could hope to acquire an intimate acquaintance with all the valuable books relating at least to any one branch of engineering. Now this is no longer possible, and the attention of students must be confined to some special branch, and these branches are narrowing more and more each year. Fifty years ago the chief engineer of a railroad was expected to—and did—design all the structures, rolling stock, and machinery on a railroad. Now, not only are the bridges, locomotives, cars and shop machinery all designed and built in separate establishments, but the various parts, even to such minute details as the split keys used to secure nuts on bolts, are made by firms who do little else. It seems, therefore, that the engineer of the future will be a person who will know all that can be known about some detail like split keys, and who need not know anything else. The "profession" of engineering—as our civil engineering brethren love to call their occupation—may in the future be likened to a honeycomb—that is, it will consist of many cells, each filled with a store of knowledge deposited there by the busy bees who occupy the hives of industry and learning. Following out the simile, the book before us may be likened to the bees' comb, which is divided into a great number of cells, and in which information, gathered from a vast number of sources, has been deposited, and classified and placed within the reach of those who are mentally a-hungered.

Mr. Kent's book may be described as a cross or halfway station between Molesworth's "Pocket-Book of Engineering Formulæ" and Linehan's "Text-Book of Mechanical Engineering," which was reviewed in our February number. The former very useful book gives only formulæ, rules, tables, data, etc., while Mr. Kent's gives more or less explanation of the different subjects referred to. These explanations assume the form of dissertations and short essays, which are often taken from technical papers, books, etc., and give an epitome of the "state of the art." Thus the introduction to the section relating to the Strength of Materials consists of a short essay from which the reader can get a better idea of the general subject than he could obtain, perhaps, from any other source. The same observation would apply to many other postures of the book.

In the table of contents the subjects are classed into general divisions, which are subdivided under heads and subheads. There is only room here for the first and second, the general divisions being printed below in capitals, and their subdivisions in small type. These include:

MATHEMATICS.—Arithmetic; Weights and Measures; Algebra; Mensuration, Plane Surfaces; Mensuration, Solid Bodies; Plane Trigonometry; Analytical Geometry; Differential Calculus; Mathematical Tables.

MATERIALS.—Miscellaneous Materials; Strength of Materials; Alloys; Ropes and Chains; Springs; Riveted Joints; Iron and Steel; Steel.

MECHANICS.—Elements of Machines; Stresses in Framed Structures.

HEAT.

PHYSICAL PROPERTIES OF GASES.

AIR.—Flow of Air; Wind; Compressed Air; Fans and Blowers.

HEATING AND VENTILATION.

WATER.—Hydraulics; Flow of Water; Water-power; Turbine Wheels; Pumps; Hydraulic Pressure Transmission.

FUEL.—Petroleum; Fuel Gas; Illuminating Gas.

STEAM.—Flow of Steam; Steam Pipes.

THE STEAM BOILER.—Strength of Steam Boilers; Boiler Attachments, Furnaces, etc.; Safety Valves; the Injector; Feed-water Heaters; Steam Separators; Determination of Moisture in Steam; Chimneys.

THE STEAM ENGINE.—Compound Engines; Steam Engine Economy; Rotary Steam Engines; Dimensions of Parts of Engines; Fly-wheels; the Slide Valve; Governors; Condensers, Air Pumps, Circulating Pumps, etc.

GAS, PETROLEUM AND HOT-AIR ENGINES.

LOCOMOTIVES.

SHAFTING.

PULLEYS.

BELTING.

GEARING.—Forms of the Teeth; Strength of Gear Teeth.

HOISTING.—Cranes; Wire Rope Haulage.

WIRE-ROPE TRANSMISSION.

ROPE DRIVING.

FRICTION AND LUBRICATION.

THE FOUNDRY.

THE MACHINE SHOP.—Abrasive Processes; Various Tools and Processes.

DYNAMOMETERS.

ICE-MAKING OR REFRIGERATING MACHINES.—Actual Performance of Refrigerating Machines; Artificial Ice Manufacture.

MARINE ENGINEERING.—The Screw Propeller; the Paddle-wheel; Jet Propulsion; Recent Practice in Marine Engines.

CONSTRUCTION OF BUILDINGS.

ELECTRICAL ENGINEERING.—Standards of Measurement; Electrical Resistance; Electrical Currents; Electric Transmission; Electric Railways; Electric Lighting; Electric Welding; Electric Heaters; Electric Accumulators or Storage Batteries; Electro Magnets; Dynamo Electric Machines.

This list will indicate that there are many subjects treated of in this new book which are not referred to in the older pocket-books. In fact, the information relating to all the subjects referred to in the book is brought up nearer to recent knowledge and practice than that in any similar book which has preceded it. This, it is true, might be expected; but when it is seen what an immense amount of labor was involved in doing this, what vast fields of literature had to be gone over to summarize what is given in such a small space, the amount of work which has been done by the author can be even then but faintly realized, and is a monument to the author's industry and ability.

The book is admirably printed on excellent thin paper, and is bound so that it opens easily and agreeably, and in that respect is in marked contrast with many recent books which require to be pried open in order to make the inner margins of the pages visible. Its dimensions, notwithstanding the large number of pages, are such that it can be carried in a not very capacious pocket.

It should be added that the book is intended especially for mechanical engineers, the field of which, the author says, "was considered so great and the literature of the subject so vast that as little space as possible should be given to subjects which especially belong to civil engineering. The latter branch," it is said further, "is so well covered by Trautwine's 'Civil Engineers' Pocket-Book,' that any attempt to treat it exhaustively would not only fill no 'long-felt want,' but would occupy space which should be given to mechanical engineering."

The book can by highly commended, and a debt of gratitude is due to the author from his brethren for giving them this new and effective instrumentality, which will be a valuable assistant in their daily work.

THE ELECTRICAL JOURNAL, an Illustrated Newspaper Devoted to the Interests of Electrical Progress and Education. Vol. I, No. 1. 20 pp. of reading matter; xvi of advertisements; 9½ × 12½ in. The Electrical Journal Publishing Company, Chicago. J. P. Barrett, President. Published semi-monthly.

It is a journalistic obligation to welcome all new-comers, although there are far too many of us cumbering the ground already. The stranger which has just been born is a comely infant, well printed and papered, and fairly well illustrated. Its "aim" in a "salutatory," it is said, will be to keep the very large class of people in this country who are interested in electricity—commercially or otherwise—the members of which are practically debarred from a knowledge of electrical principles and laws owing to the deeply scientific and mathematical character of existing text-books and current literature, posted on electrical matters, and to present for their information and entertainment items and discurses on every conceivable subject." It is a wide field to undertake to occupy, but one which, if well cultivated, let us hope will bring forth a plenteous harvest.

NOTES ON RANKINE'S CIVIL ENGINEERING. By David C. Humphreys, Professor of Applied Mathematics in Washington and Lee University. For sale by the Author, Lexington, Va., and by Charles Scribner's Sons, New York. Price, $4.

These notes, which are in lithographed, round writing, and occupy 184 large quarto pages, are an extension of those published in 1873 by Professor William Allen, of Washington and Lee University. It thus appears that the works of Rankine have been used in this institution for a period of twenty years

or more. Twenty or thirty years ago Rankine's text-books were almost the only ones giving advanced theoretical discussions of mechanical principles directly available for technical schools. To-day, however, they are but little used on account of their obscurities and the fact that numerous other text-books on modern lines of thought can be had. Rankine was a master of theoretical mechanics, but he wrote in the days when it was considered proper to present the subject in an obscure and difficult form. The simple question of stresses in trusses, for example, is overloaded with complex formulas, so that a student, even with the assistance of these notes, can gain but an imperfect knowledge of the methods used in practice. Very few numerical examples or problems illustrating the principles of statics can be found either in Rankine's civil engineering or in Professor Humphreys' notes. It may be that a student who has burned the midnight oil over formulas for the dead load stresses in the nth strut of a Warren girder has gained some mental discipline, but one who is taught to compute the stresses due to locomotive wheel-loads without any formulas at all certainly has a far better understanding of the principles of statics. Teachers of engineering will find these notes useful when they consult Rankine, for Professor Humphreys has done much to clear away many difficulties, and the list of 69 errors that he has discovered in the text shows that even the formulas of a master must be used with great caution.

BOOKS RECEIVED.

PROCEEDINGS OF NEW YORK RAILROAD CLUB. Meeting of May 16, 1895. Discussion on Tools for Locomotives and the Inspection of Steel-Tired Wheels.

PROCEEDINGS OF THE WESTERN RAILWAY CLUB. Chicago, April 16, 1895. New Constitution; Discussion on Train Staff System; on Strength of Car Axles; on Interchange Rules.

PROCEEDINGS OF THE NEW ENGLAND RAILROAD CLUB. Boston, May 8, 1895. Electrical Apparatus in Connection with Signalling and Moving of Trains, papers by J. V. Young and J. P. Coleman.

PROCEEDINGS OF THE FOURTH ANNUAL MEETING OF THE AMERICAN INTERNATIONAL ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS, October 16, 17, and 18, 1894. 104 pp., 6 × 9 in.

PROCEEDINGS OF A NATIONAL CONVENTION OF RAILROAD COMMISSIONERS, held at the office of the Interstate Commerce Commission, Washington, D. C., May 14, 1895. First Day's Proceedings. 37 pp., 5¼ × 9 in.

PROCEEDINGS OF THE SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Atlanta, Ga., April 18, 1895. Discussion of the Code of Rules Governing the Condition of and Repairs to Freight Cars for the Interchange of Traffic.

PROCEEDINGS OF THE CENTRAL RAILWAY CLUB. Buffalo, April 24, 1895. Discussion of the Report of the Committee on Revision of the Constitution and By-Laws; Report of the Committee on Revision of the Rules of Interchange.

PROCEEDINGS OF SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Meeting of April 18, 1895. Review of Master Car-Builders' Rules; Report of Committee, and discussion thereof; Uneven Wear of Driving-Wheel Tires; Report of Committee and discussion; Most Economical Method of Obtaining Compressed Air; Report of Committee and discussion; the Most Economical Tonnage Spring; Report of Committee and discussion.

AMERICAN SOCIETY OF CIVIL ENGINEERS, March, 1895. Transactions, Vol. XXXIII, No. 3; Proceedings, Vol. XXI, No. 3. Paper on the Bridge over the Tennessee River at Johnsonville, Tenn., by Hunter McDonald, with discussion. Paper on Wind Bracing in High Buildings, by Guy B. Waite, with discussion. Paper on the Relative Effects of Frost and the Sulphate of Soda Efflorescence Tests of Building Stones, by Lea McI. Luquer. Minutes of Meetings.

BEESON'S INLAND MARINE DIRECTORY. 302 pp., 6¼ × 9¼ in. Eighth Annual Edition. This useful publication contains lists of American and Canadian Lake and River Merchant Steam and Sailing Vessels, Owned and Operated on the Northwestern Lakes and Waters Tributary Thereto; and a variety of other data and information relating to marine matters on the lakes. It is compiled in its usual convenient form, and contains a liberal number of advertisements.

PROCEEDINGS OF THE MEETING OF THE AMERICAN RAILWAY ASSOCIATION, held at the Planters' Hotel, St. Louis, Mo., April 17 and 18, 1895. 103 pp., 7¼ × 10¼ in.

The "Proceedings" at this meeting include Reports of the Executive Committee; on Arrangements for the International Railway Congress; on Standard Wheel and Track Gauges; on Train Rules, and a long discussion thereon; on Car Service; on Safety Appliances; on Location of Handholds and Grab Irons; on Interlocking and Block Signals, and a discussion thereon; Rules of Order of the Association; Address of the President, Mr. H. S. Haines; Schedule of the Proceedings of the International Railway Congress.

ENGINE AND BOILER ROOM. Vol. I, No. 1. This is the first number of a new monthly engineering periodical which has just been launched in Chicago, and of which Mr. S. K. Monroe is Manager; T. P. Pemberton, Editor; and A. Bement, Associate Editor. Its size is 7 × 10 in., and contains 18 pages of reading matter. It is well printed and fairly well illustrated, but the price being only 50 cents per year, single copies 5 cents, perhaps the highest style of the illustrator's art could hardly be expected or demanded. It is always gracious to wish a newcomer good luck and prosperity. In the present instance the publishers have made an attractive paper, and whatever the measure of success, it seems the publishers and editors must certainly be credited with courage and temerity in putting afloat another journalistic bark on a sea which is now so much overcrowded.

TRADE CATALOGUES.

IN 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

IT seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.

STANDARDS:

For postal-card circulars	3½ in. × 6½ in.
Pamphlets and trade catalogues	3½ in. × 6 in. 6 in. × 9 in. 9 in. × 12 in.
Specifications and letter-paper	8½ in. × 10¼ in.

THE last number of the *Official Gazette* of the United States Patent Office contains the following notice:

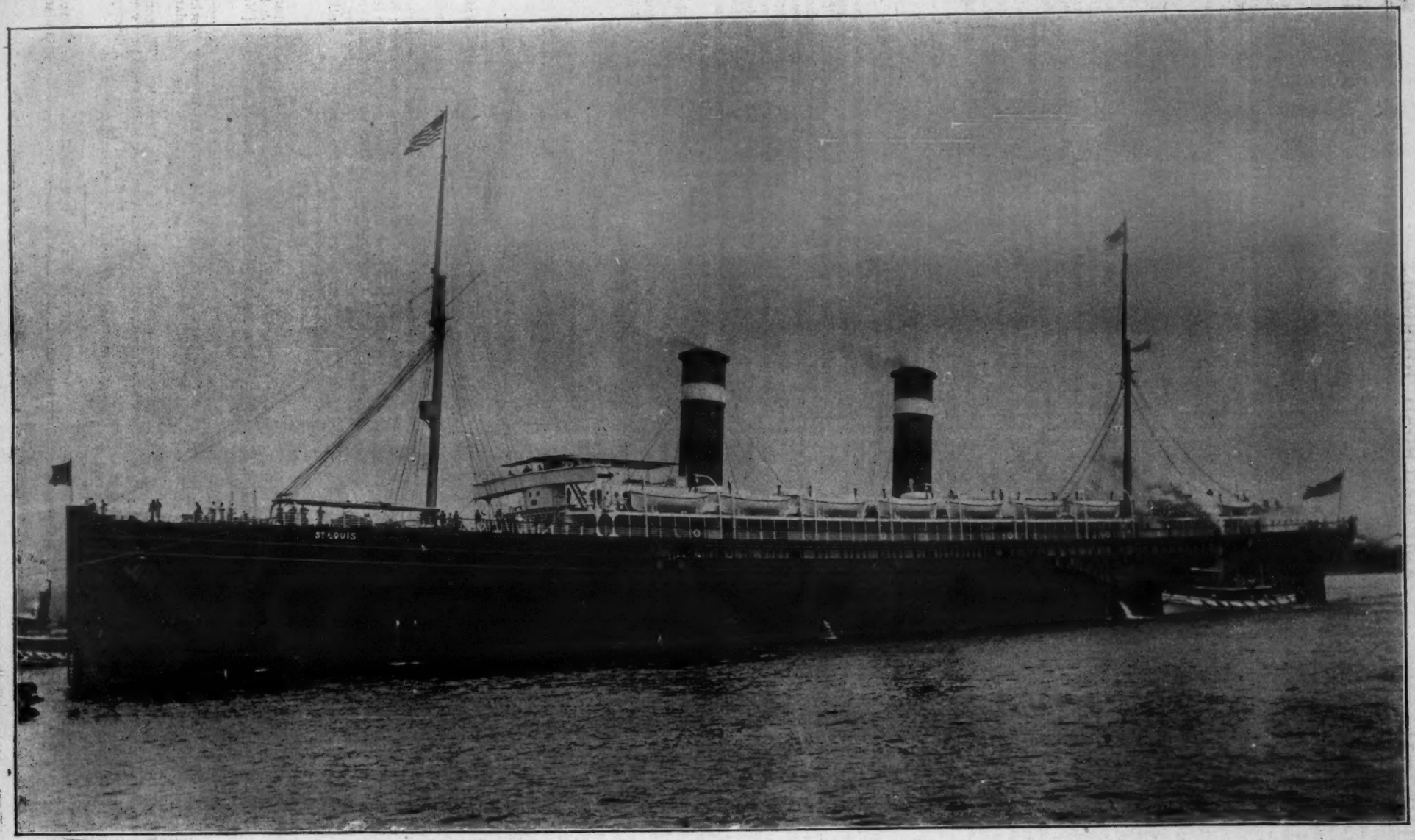
"This office would be pleased to receive from manufacturers and publishers such catalogues, circulars, price-lists, or other advertisements relating to the sciences and mechanical arts as are published by them for gratuitous distribution; but notice is hereby given such manufacturers or dealers who feel disposed to send their publications that not less than three copies should be forwarded in order that the subjects may be properly indexed, classified, and sub-classified in the Scientific Library for convenient and ready reference."

PENCOYD IRON WORKS. Bridge and Construction Department. General Specifications for Railroad Bridges. A. & P. Roberts Company, Philadelphia. 20 pp., 6¼ × 10 in. [Not standard size.]

AIR OR GAS COMPRESSORS DRIVEN BY CORLISS ENGINES, BELT OR ROPE. Built by Philadelphia Engineering Works, Limited, Philadelphia. 4 pp., 6 × 9¼ in. [Not standard size.]

The title of this leaflet indicates its character. The compressor manufactured by this company is illustrated by very good wood-engravings—side view and plan—with a description and statement of its advantages accompanying it.

COMBINE SAFETY WATER-TUBE BOILER. L. M. Moyes, Manufacturer, Philadelphia, Pa. 8 pp., 6 × 9 in. [Standard



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THE STEAMSHIP "ST. LOUIS," OF THE AMERICAN LINE, BUILT BY THE WILLIAM CRAMP & SONS SHIP AND ENGINE BUILDING COMPANY.

size] This little pamphlet sets forth the arguments in favor of the "combine" boiler illustrated in our last number, and is in part a reply or comment on "Facts" published by the Babcock & Wilcox Company. It is without illustrations, and gives merely the reasons for the superiority of this type of boiler.

SPEIDEL'S PATENT ECONOMIC SAFETY HOISTS. Speidel Brothers, Reading, Pa. 28 pp., $4\frac{3}{4} \times 7\frac{1}{4}$ in. [Not standard size.]

This Company makes portable hoists, overhead tramways, travelling cranes, portable derricks, stationary and cellar hoists, all of which are illustrated and described in the publication before us. The illustrations are good wood-cuts, and tables of sizes and capacities are given in convenient and attractive form.

STEAM PLANTS FOR DRIVING DYNAMOS IN ELECTRIC-LIGHT, RAILWAY, AND POWER STATIONS, AND ISOLATED PLANTS, ETC. The Pond Machinery Company, 709 Market Street, St. Louis, Mo. 17 pp., $3\frac{1}{4} \times 6$ in. [Not standard size.]

The purpose of this little publication is to give an advertisement of the business of the Pond Company and a statement of what they are prepared to do, and it also gives a long list of steam plants which the Company has furnished in whole or in part.

ECONOMY GUARANTEES OF ENGINES. The Westinghouse Machine Company, Pittsburgh, Pa. 12 pp , $3\frac{5}{8} \times 6$ in. [Not standard size.]

In this little pamphlet the Westinghouse Company announce that they will give an economy guarantee of the performance of their engines, and that purchasers can have their engines tested by their own experts at the Westinghouse shops before shipment if they so desire, and may accept or reject the engine on that test before incurring the expense of installation.

ELECTRIC ELEVATORS. Catalogue of Sulzer-Vogt Machine Company, Louisville, Ky. 20 pp., 6×9 in. [Standard size.]

In the "introductory" this company says that "electric elevators have long since ceased to be an experiment, and are now the most economical elevator, not only in cost of running, but in space occupied and convenience and ease of operation." They illustrate with good wood engravings the hoisting machines for freight and passenger elevators, various forms of platforms and elevator cars, and other appliances which are furnished, all of which are described.

THE WE-FU-GO PROCESS OF PURIFYING FEED-WATER FOR STEAM BOILERS, HEATERS, ETC. The We-Fu-Go Company, Cincinnati, O. 19 pp., $3\frac{1}{4} \times 6\frac{3}{8}$ in. [Not standard size.]

The fact that Mr. Fred. C. Weir is President and N. O. Goldsmith Vice-President of this Company would indicate that it is not composed of Chinamen, as its title would suggest. Their trade catalogue is a brief elementary treatise on incrustation. Little information is given with reference to the process with the barbaric name, excepting that "it precipitates the scale-forming impurities by converting them into an insoluble condition by the addition of chemical reagents."

ECONOMY WATER-TUBE BOILER. Economy Water-Tube Boiler Company, New York.

This Company have published a descriptive catalogue of their boiler, which is in the highest style of this class of literature. It is illustrated with admirable wood engravings of the boiler and its details. The descriptive matter explaining its construction and operation is also excellent, and will enable the reader to understand both without any other effort excepting that of reading the description attentively. The cover, especially, is an attractive one, and the publication as a whole should incline those who receive it to regard the boiler favorably.

RAILROAD EDITION. CATALOGUE AND PRICE-LIST OF MECHANICAL RUBBER GOODS. 62 pp , $3\frac{1}{4} \times 6$ in. [Standard size.]

ILLUSTRATED CATALOGUE AND PRICE-LIST OF RUBBER MATS, MATTING AND STEP TREADS. Boston Belting Company, Boston and New York. 14 pp , $3\frac{1}{4} \times 6$ in. [Standard size.]

The articles manufactured by this company which are used by railroad companies include belting, hose of various kinds, packing, gaskets, valves, tubing, rubber springs, diaphragms, rubber mallets, matting and flexible rubber hose-pipes, all of which are illustrated in the two pamphlets before us, which are well printed; the engravings are good, and all but the binding can be commended. The latter is done with wire, and holds the leaves together and prevents them from being opened comfortably.

STANDARD EVAPORATION COMPUTER. Designed by William Cox. The Babcock & Wilcox Company.

This company have issued a very neat and convenient device for making calculations which are based on the formula

evaporation in pounds from and at 212° $= W \frac{H - h}{966}$, in which

W is the weight of water or steam in pounds at actual pressure and temperatures, H is the heat units in the steam, and h is the heat units in the feed-water per pound, and any calculation depending upon this formula may be made with it. It consists of a circular cardboard disk graduated, which revolves in contact with other segmental graduations and scales, the arrangement and purpose of which could not be explained so as to be intelligible without engravings. The whole is mounted in a neat morocco case in convenient form.

THE CAHALL VERTICAL WATER-TUBE BOILER. Manufactured by the Aultman & Taylor Company, Mansfield, O. Third Edition. 45 pp., $5\frac{1}{4} \times 7\frac{1}{4}$ in. [Not standard size.]

The "Cahall" boiler consists of an upper and lower drum, which are connected by 4-in. tubes. The products of combustion impinge against the tubes above the lower drum, and then pass around the tubes and escape through a central opening in the upper drum and thence to the chimney. The publication is illustrated by half-tone engravings representing a view of the works and different parts of the boiler, and some excellent wood-engravings representing sectional views of the boiler. A number of views made from "wash" drawings show external views of groups of boilers and their setting. The descriptive matter and reports of tests are all very clearly presented, and enable the reader to get a very good idea of the boiler and its merits.

THE OFFICIAL RAILWAY LIST, 1895. Fourteenth Annual Edition. Published by the Railway Purchasing Agent Company, Chicago. 422 pp., $4\frac{1}{2} \times 8\frac{1}{4}$ in.

The "List" comes to us again this year with more pages, more advertisements, and a general appearance of more prosperity. An extract from its copious title-page will describe the character of the book to those not acquainted with it. It is said there that it is "a complete directory of the presidents, vice-presidents, general managers and assistants, general and division superintendents, chief and assistant engineers, secretaries, treasurers, auditors, traffic managers, general freight agents, general passenger and ticket agents, baggage agents, superintendents of telegraph, purchasing agents, fuel agents, car accountants, superintendents of motive power, master mechanics, master car-builders, master car-painters, foremen of repairs, roadmasters, etc., of railways in North America, and handbook of useful information for railway men"—all of which it is, and more too.

THE WAINWRIGHT STEAM APPLIANCES. Made and sold by the Taunton Locomotive Manufacturing Company, Taunton, Mass. 64 pp., 8×10 in. [Not standard size.]

The "appliances" referred to in the title are feed-water heaters, surface condensers and expansion joints. The Wainwright feed-water heater consists of a cylindrical vessel with two tube-plates at some distance from its ends, and covers on the ends. Corrugated tubes extend from one tube-plate to the other, and are fastened to them in the usual way. The tubes communicate from the space between the tube-plate and head at one end to that in the other. The exhaust steam is admitted to the space between the two tube-plates, and surrounds the tubes. Cold water is admitted into the space at one end—the lower one when the heater is placed vertically, as it usually is—and circulates through the tubes, and is thus heated in the usual way. A marked characteristic is the corrugations of the tubes, which increases their heating surface materially and gives them some longitudinal flexibility. Different forms of this heater and their applications are described and illustrated, although the descriptions are not quite as satisfactory as they might be.

A similar use is made of corrugated tubing—which is a specialty of this company—in the construction of surface condensers, and also expansion joints for steam piping, all of

which are described and illustrated. The printing, engraving and paper in this publication are all excellent.

PROOFS OF "SERVIS." A Collection of Photographs. 24 pp., 6 × 9¼ in. [not standard size]. The Q. & C. Company, Chicago.

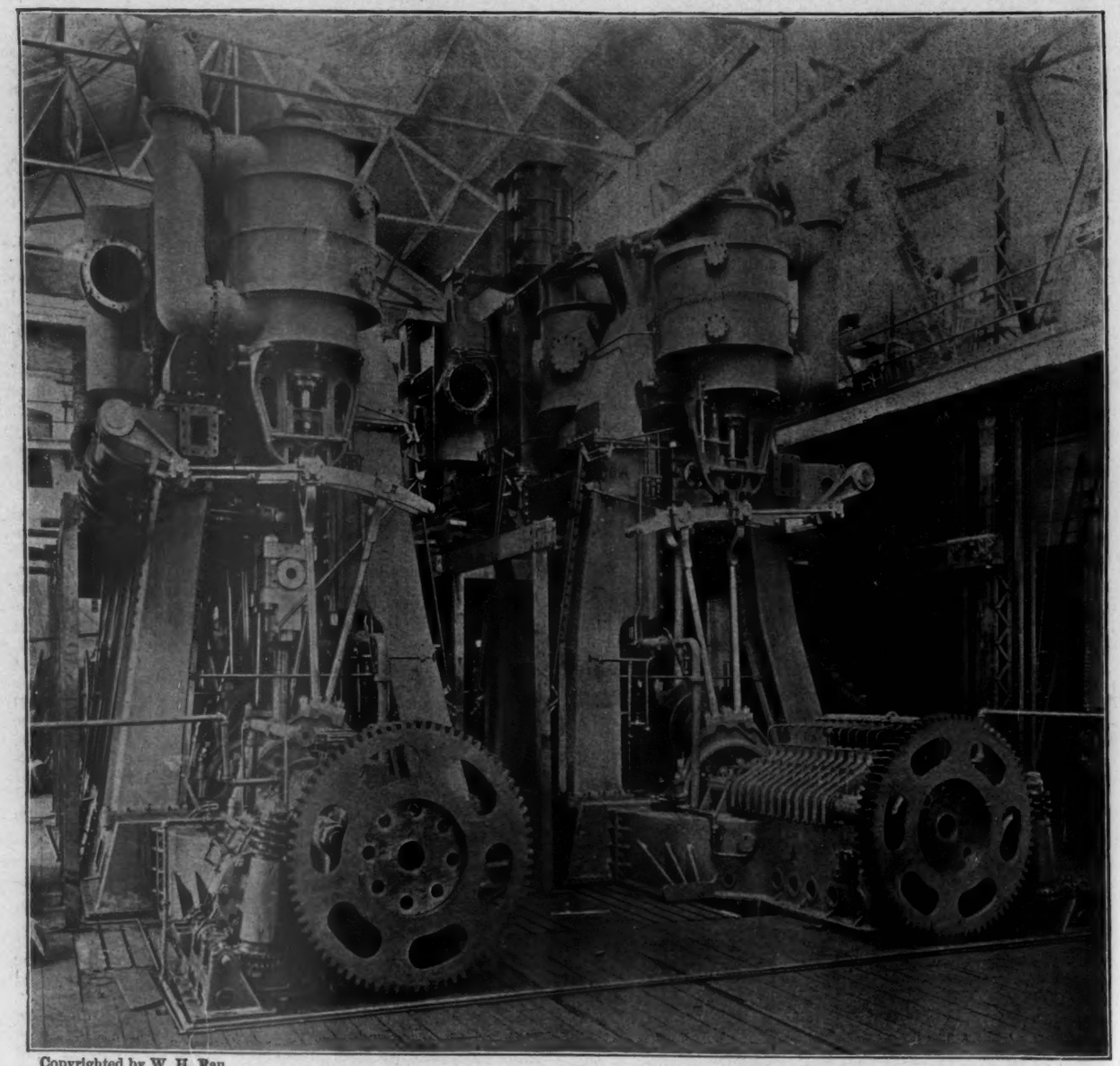
In their introduction the publishers explain its *raison d'être*, which is as follows:

"At the last annual meeting of the Road Masters' Association of America there were sent to us a large number of specimen cross-ties illustrating the mechanical failure of ties, and the protection afforded to same by the longitudinal flanges of the Servis tie-plates, which united themselves to the ties and protected the wood fibre from displacement. While on exhibition at New York, these ties were examined with considerable interest by many general officers of several different railways located in and about that city, and it was decided to select a few of the ties and exhibit them at different points. The ties herein photographed were selected, and were moved to and shown at many points, and never failed to awaken a deep interest in those who studied them. The impossibility of covering the entire country suggested a reproduction of the exhibit in album form, with a short description of each exhibit."

The ties are represented by half-tone engravings made from excellent photographs, and show the samples to good advantage. Some engravings at the end of the book show samples of worn-out plates, a diagram indicating the evolution of the tie-plate and another representing various forms of Servis plates. The use and efficiency of these appliances are well described, and the catalogue is a creditable example of this kind of literature.

THE STEAMSHIP "ST. LOUIS."

THE new American Line steamship *St. Louis*, toward which so much attention has been directed during the past two years, has made her maiden voyage across the Atlantic and back. The vessel was built by the Cramp Ship-building & Engine Company for the International Steamship Company. The first frames were erected on July 23, 1893, and she was launched



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AFTER END OF MAIN ENGINES OF THE STEAMSHIP "ST. LOUIS."

15 months later. Her dimensions are: Length, 554 ft.; length between perpendiculars, 535 ft.; extreme breadth, 63 ft.; moulded depth, 42 ft.; number of decks, 5; number of watertight compartments formed by transverse bulkheads and flats, 17; distance of collision bulkhead abaft of stem, 33 ft.; displacement at 26 ft. draft, 16,000 tons.

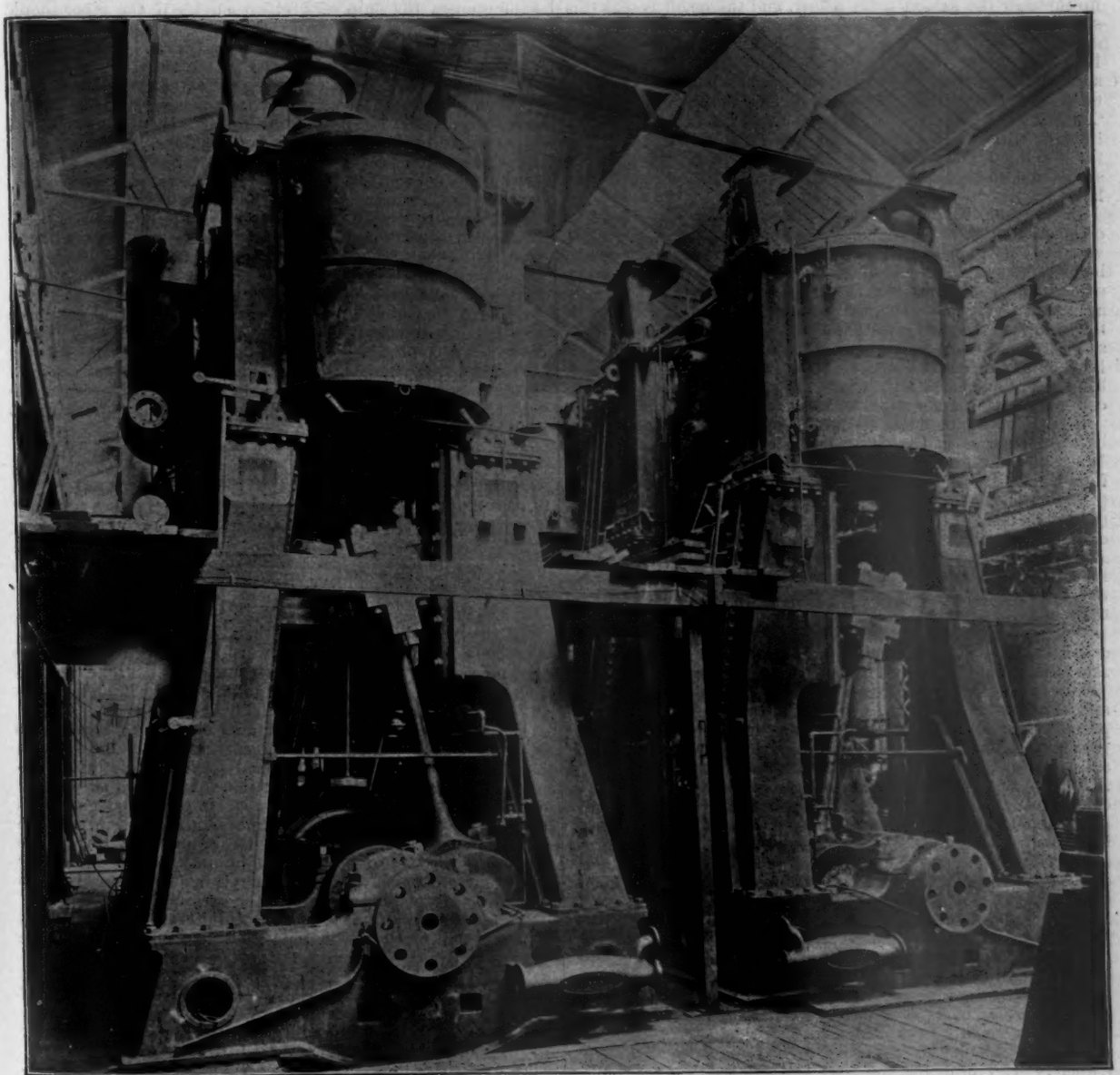
The *St. Louis* sailed on her first voyage from New York for Southampton on Wednesday, June 5, making the voyage in seven days, three hours and 53 minutes at an average speed of 18.37 knots. On the return she left Southampton June 15, and passed the Sandy Hook lightship June 22, making the voyage in 7 days, 7 hours and 11 minutes.

The company and builders disclaim all intentions of making

a record breaker of the new steamer, and instead, of making the three great requisites stand in the order of "safety, speed, comfort," the positions of the last two have been changed so that they stand "safety, comfort, speed." The *St. Louis* and her sister, the *St. Paul*, which is rapidly approaching completion, are therefore expected to be running mates of the *New York* and *Paris*, and with them to make an even and regular performance, so that the hour of arrival can be thoroughly depended upon.

The appearance of the vessel is well shown by the large engraving on page 298. It will be seen that the bow is square, and in this respect differs from the overhang or "yacht" bow of the *New York* and *Paris*. There is also another difference in that two stacks are used on the *St. Louis*, while the *New York* and *Paris* each have three. The engravings of the engines on pages 300 and 301 are reproductions of photographs taken after the engines had been assembled in the shops. These engines are of the quadruple-expansion type, with cylinder diameters as follows: Two high-pressure cylinders, each 28½ in. in diameter; first intermediate, 55 in. in diameter; second intermediate, 77 in. in diameter; two low-pressure, each 77 in. in diameter. The boiler pressure is 200 lbs. per square inch, supplied by 10 boilers of the Scotch type, with four furnaces for each end. Six of these boilers are double-enders and four single enders, making a total of 72 furnaces. In addition to the main engines there are 49 auxiliary engines used in the working of the ship, and 12 additional ones for lighting and ventilating the vessel, independent of the propelling machinery.

The coal consumption is placed at 300 tons per day at a speed of 19 knots and a gross tonnage of 11,629. Up to the present time the vessel has had no definite trial trip, upon which the United States Government mail contracts will be awarded. This is to be a continuous run of four hours at sea at an average speed of 20 knots, and the company have until October 1 to fulfil this engagement. It is expected, however, that the vessel will make such a record on the regular runs during the summer that the official trip will be dispensed with, and that the Government will accept the vessel as a portion of the auxiliary navy.



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FORWARD END OF MAIN ENGINES OF THE AMERICAN LINE STEAMSHIP "ST. LOUIS."

There are two passenger decks to the vessel, in addition to the promenade deck, and on each one has the most careful effort been expended to secure the comfort of the passenger. The uppermost deck is the promenade deck. Here is where the passengers spend most of their time. It has unusually good conveniences and spaces. Not only is there a flush deck along the entire length of the ship, but the promenade is clear from all interference by stays or benches. All along the sides of the ship are numerous alcoves, set in between buttresses formed by the spaces given up to the ventilating and heating apparatus, and in these sheltered places the cabin passengers will find room for their chairs and at the same time give an unimpeded space for the promenade. In the deck-house on

this deck are the ladies' drawing-room and elaborately furnished suites of rooms, each suite comprising bedroom, bath-room, and sitting-room. The roof of the deck-house, where all the quarters of the navigating officers are situated, is extended clear over to the sides of the ship, making a covered promenade for the passengers. Back of the chief deck-house on the promenade deck is another house, and in the forward end of this house is the first-cabin smoking-room. In the back part of this is the second-cabin ladies' saloon and the companion-way to the second cabin. Back of all this is the second-cabin smoking-room.

The main saloon also can seat the entire complement of first-cabin passengers at one time, which experienced travellers will appreciate. Moreover, there are no pillars or pipes running up through the saloon from below, and the result is that this ship has undoubtedly the most commodious and best-lighted saloon of any ship yet built. It is 110 ft. long and 50 ft. wide. It has seats for 350 passengers at one time. It is situated amidships, between the two funnels, where there is the least motion, and, with the exception of the *Paris* and the *New York*, is on a higher deck than on other ocean liners. As is the case with the *Paris* and the *New York*, it is lighted from the top by a glass dome of large proportions and graceful shape, and on the side are rectangular windows instead of port holes.

In front of this saloon, and separated from it by the main companion-way, is the library, probably the largest room devoted to that purpose on any ship. Back of the main saloon is the pantry, and backed up against that is the pantry for the second cabin. Still back of this is the second-cabin saloon, also an unusually large room, and fitted with revolving chairs at the tables instead of the usual settees. The tables in this saloon, as in the first-cabin saloon, run lengthwise of the ship. Back of this is the doctor's office and then a large space under the after promenade deck, where the steerage passengers may congregate in weather when a shelter is needed.

In the matter of decorations and fittings the same rule has been followed as in the construction of the rest of the ship. Where decorations are expected and are in good taste they are found. Where there is nothing to be gained by a useless appeal to the eye there has been no waste of money. They are most elaborate, of course, in the first-cabin saloon. This spacious apartment is finished in white mahogany. The panels about and under the glass dome are filled in with paintings of musical figures and sea nymphs engaged in playful contest in the sea. At the after end of the glass dome is a figure of Neptune with his trident, in an attitude of supremacy over the waves, and directly opposite at the forward end of the dome is a spirited figure of a mermaid holding up the gallery to the saloon in which the pipes of the great organ are placed.

The entire scheme of decoration for the ship is one of light and serviceable color. In the special suites of rooms on the promenade deck, the sides of the rooms are in panels that suggest here and there old ivory, with a slight dash of color to set off the figures. The main companion-way is stately and is in red mahogany. The ladies' drawing-room is finished in ivory color, and the upholstering is of light brocade, with a delicate figure. The library is finished in oak. The first-class smoking-room has leather fittings and dark wood. It has accommodations for 100 persons, and the fact that it is on the promenade deck is one of the novelties of the ship. It has bluish panels of attractive design, and in its centre is a glass well that gives light to the rooms below.

The second-class apartments are as pleasing to the eye as many of the first-class apartments even on ships of the present day. The ladies' sitting-room is finished in cherry, with panellings of appropriate color. The second-class smoking-room is finished in birch and cherry, and is one of the most attractive apartments on the ship.

The color scheme for the upholstery of the first-cabin state rooms is steel blue for one deck and old gold for the other. These rooms are of an unusual size, and as a rule are painted white. The ironwork is in sight in them, and in the interest of absolute cleanliness there has been no effort to cover it up with wood-work or useless decorations. The white paint makes an attractive room, and the color of the fittings give a sufficient variety to the eye to make the rooms most pleasing.

In cold weather fresh air is heated by means of ventilators near the top and the bottom of every apartment; the passenger may regulate the temperature and the ventilation as he chooses. By this superior system the inner rooms of the ship are as comfortable as the outer ones, the only difference between them being that the occupants of the outer rooms may get a glimpse of the water from the portholes. In the matter of safety, extra care has been taken with the bulkhead system, which are intact and without doors below the water-line, excepting in a few places in the engine department, where special means are adopted for closing them, and where the engineers are always on watch. The vessel is so divided that in case of collision two, and even three, water-tight compartments could be flooded and not endanger the safety of the ship. The fastening edges of the bulkheads have been made unusually secure, so that if the ship sustained a shock in that place in collision the chances are that only one compartment would be flooded. This same arrangement has been made in the engine and boiler spaces. The boilers are in two groups, one group for each funnel. They are entirely separated from each other; and if one set of boilers became incapacitated the other set could do the work of supplying steam to the engines at a moderate rate of speed. The engines likewise are cut off from each other by water-tight compartments, and it would be possible to run the ship with either engine if the other should break down.

The lighting system is also very elaborate. All told, there are more than 1300 electric lights in the ship, and four large dynamos are required in operating the extensive electric plant.

Among the more recent of the improvements that have been introduced is the housing of the patent anchors in the hawse pipes instead of on deck, as is usually done. There is also a large post-office room, where letters are sorted by the clerks during the voyage, and in connection with which there is a mail hatch which operates something like a hod-carrier's windlass, which may be seen in operation in any large building. An endless chain with shelves at regular distances is kept in operation, and the bags are stowed on it or taken from it as it revolves.

It will thus be seen that every possible attention has been paid with the end in view of securing a vessel that combines the three requisites of ocean travel in the order already given. Even the accommodations of the steerage are fitted with baths and sleeping accommodations in excess of those usually found. The passenger capacity of the ship is: First cabin, 350; second cabin, 200; steerage, 800. The crew will number about 400.

SOME TESTS WITH FUEL GAS, CONDUCTED BY THE SOUTHERN PACIFIC COMPANY AT SACRAMENTO, CAL.

By A. J. Treat, San Francisco, Cal.

It can truly be said that neither the inventor nor the mechanical engineer has been backward in discoveries tending to greater economy in the use of steam. It is not an exaggeration to say that each day brings to life and to light some improvement in this branch of mechanics.

Unfortunately, it cannot be stated that like progress has been made in the method of *producing* steam, though it must be patent to all that its economical production is just as important as its economical utilization. Improved triple and quadruple-expansion engines, new valve gears and governors and condensers, each without number, and each warranted to effect a saving in the quantity of steam necessary to produce a given power, are urged upon the public with ever-increasing zeal; but comparatively little if anything is accomplished to effect an appreciable economy in the use of *coal*.

As a matter of fact, it is doubtful if the most improved boiler of to-day equals, in point of all-around economy, the Galloway boiler of 20 years ago. The latest style of water-tube boiler is far less bulky and a more rapid steamer, it is true; but if the question be as to dry steam and the life of the boiler, as well as the apparent evaporative efficiency, some of the comparatively old-fashioned affairs for the raising of steam are about equal to the water-tube boilers of to-day.

The difficulty in the way of a nearer approach to the obtainment of the theoretical value of coal seems to be largely one of principle. The system of burning coal to-day is practically that pursued in the days of Stephenson, and the difficulties which then presented themselves have been but partially overcome. Let us for a moment review the process:

When fresh coal is thrown into a furnace, decomposition begins first on the surface of the lumps; the moisture, of which there is always a percentage present, together with the volatile matter contained in the coal, is freed. While yielding up this volatile matter, the fresh lumps absorb heat until they too become incandescent. Unfortunately this absorption of heat and this giving off of the volatile gases occurs at a time when it is impossible to supply to those combustible gases the air necessary to their complete consumption. The particles of coal freshly thrown in lay in a mass, more or less preventing the ingress of the fresh supply of air, while the grate bars,

clogged with the ashes, add to the difficulty by keeping back the necessary supply of oxygen, which should freely pass through them, and which is so vitally essential to the consumption of the volatile gases rising in clouds from the fresh coal.

In the endeavor to overcome these difficulties, which are incident to and inseparable from the ordinary method of burning coal upon the grate bars of all the standard forms of boilers, a supply of air is admitted which is far beyond what is theoretically necessary. To obtain this supply, huge stacks are constructed, the openings for air below the grate bars—the ash-pit doors—are enlarged, or, what is least objectionable, a forced draft of air is employed.

The complicated series of gases known as hydrocarbons, set free during the decomposition of coal resulting from heat, arise, as suggested, in largest quantities when it is least possible for a supply of air to reach them. Not receiving the necessary supply of oxygen at the proper time, they are carried up the stack and into the atmosphere. A large volume of gas, capable of giving out heat, could it have been retained and properly mixed with air, is thus lost.

A single lump of coal thrown upon an incandescent bed of coals is thoroughly consumed, and nearly all its hydrocarbons utilized, because there comes to it, with but little interruption, sufficient heat and a sufficient supply of air. But where there is thrown into a furnace a charge of coal, the fresh layer forms an intervening mass between the hot bed of coals below and the gases above. In consequence, these gases, lacking the air necessary to their consumption, separate, pass up the stack, and give forth the finely divided particles of carbon commonly known as smoke. The cause and effect is similar to that of a lamp wick which has been turned too high—the gases of combustion are in excess of the air which is necessary to complete consumption.

It is not necessary to enter here into a discussion of the "smoke nuisance." By careful firing smoke can be allayed, but under present systems it cannot be prevented. A mistaken idea exists as to the amount of actual carbon contained in those dense masses of smoke which are seen rising from the tall stacks of manufacturing and other large plants. By passing through water the gases arising from a furnace burning bituminous coal, and weighing the solid particles retained or precipitated, it has been proved, it is claimed, that they amount to less than one-sixth of 1 per cent. of the total amount of coal consumed. It is not strange that a different idea is entertained of the quantity of actual carbon seemingly going to waste when the wonderful coloring power of the finely divided particles of carbon is considered. To prove this it is only necessary to try the well-known experiment of smoking a bit of glass with a candle, and then mixing up with a palette knife a portion of the coloring matter thus secured with a drop or two of gum arabic. A very small portion of this mixture will color many quarts of water, and in the same proportion that the air is discolored by the dense volumes of smoke issuing from the average factory smoke-stack.

Smoke, then, is the result of a condition which can be remedied to some extent, but not, under present conditions of burning coal, materially changed. Smoke is both the result and the evidence of incomplete combustion. The actual carbon contained in the smoke itself is inappreciable; but the unconsumed invisible gases invariably associated with the smoke are considerable in quantity, and indicative of a financial loss much larger than is generally known.

While it has always been understood that the generation of heat from coal, as ordinarily obtained under a boiler, was imperfectly carried on—that the gases were not, and under the conditions could not be thoroughly mixed with that quantity of air necessary to their complete combustion—singularly but little attention has been paid to possible variations of the method ordinarily employed.

At least theoretically the system of heating by gases generated in a producer carries with it the remedy for the shortcomings of the grate system of firing. The difficulty heretofore, however, has been in the practical application of the system.

The process as first introduced, and which has not been materially changed, consists in distilling or volatilizing the fuel in a producer, thus turning it into its carbonic oxides and hydrocarbon gases. The first experiments with fuel gas were highly successful in the gain in evaporative efficiency, but the attempts heretofore made to introduce the system commercially have failed, mainly because of the expense formerly necessary to maintain and equip a plant, and also because more skilful handling has been required than could be expected of the average laborer found in the boiler room.

The foregoing observations upon combustion have been made somewhat in the nature of a preface to the following remarks upon and extracts from a series of experiments conducted upon lines differing slightly from those generally in vogue. The tests referred to were recently made in the boiler-room of the machine shops of the Southern Pacific Company at Sacramento, Cal. The object in view was the determination of the economy of fuel gas as against grate-bar firing, and particularly to test a patented furnace specially designed by the A. S. B. Company for the purpose of utilizing cheap coal (Ione lignite).

The tests were made by Mr. Howard Stillman, Engineer of Tests, under the direction of Mr. H. J. Small, the Superintendent of Motive Power and Machinery. The following extracts, tables, and diagram are from the report of Mr. Small to Mr. W. G. Curtis, Assistant to the General Manager:

SACRAMENTO, February 20, 1895.

W. G. Curtis, Esq., Assistant to General Manager:

DEAR SIR: Great care was taken to obtain actual data, and I can say the report very clearly exhibits the merits of the device, and we can safely say that the best efficiency from Ione coal can be obtained by its use in a gas producer. Carbon Hill coal does poorly in the producer, while Nanaimo does well.

Yours truly,

(Signed) H. J. SMALL,
Superintendent of Motive Power and Machinery.

SACRAMENTO February 11, 1895.

H. J. Small, Esq., Superintendent of Motive Power and Machinery:

DEAR SIR: With each fuel the tests were made on three consecutive nights, from six P.M to six A M., the boilers supplying steam to run the electric engine. The boiler used was of locomotive type—same one as used on previous tests with gas producer—and one of a battery of three.

The test boiler was so connected as to supply steam to the electric light engine alone, though one or more of the other boilers could be cut in if necessary, as when steam pressure fell down below 40 lbs. owing to any cause.

Except with Nanaimo coal, the producer had to be cleaned out and started again at midnight of each test, a process requiring from ¾ to 1¼ hours. Under these conditions the steam pressure fell off, and it became necessary to cut in the other boiler as stated. The action of producer was irregular at times, owing to conditions producing a varying quantity of gas, conditions varying again with each fuel used. For these reasons it became necessary to study the action of each fuel in producer, and the "personal equation" entered largely into matter of successful operation. It will be understood that producer was in operation some time on working days, and trials and experiments made with each fuel to endeavor to obtain the best results. At such times the firemen in charge were instructed, and during the tests it was essential to have the same man run the producer to obtain uniform results in operation. The man in charge during the tests was allowed to run the producer without expert assistance. The Ione coal acted fairly well in the producer; the amount of heat generated in the producer was not great, and pipe conveying gas to boiler was easily kept from redness. The great accumulation of ashes from this fuel required a longer time at midnight to clean out, as above referred to.

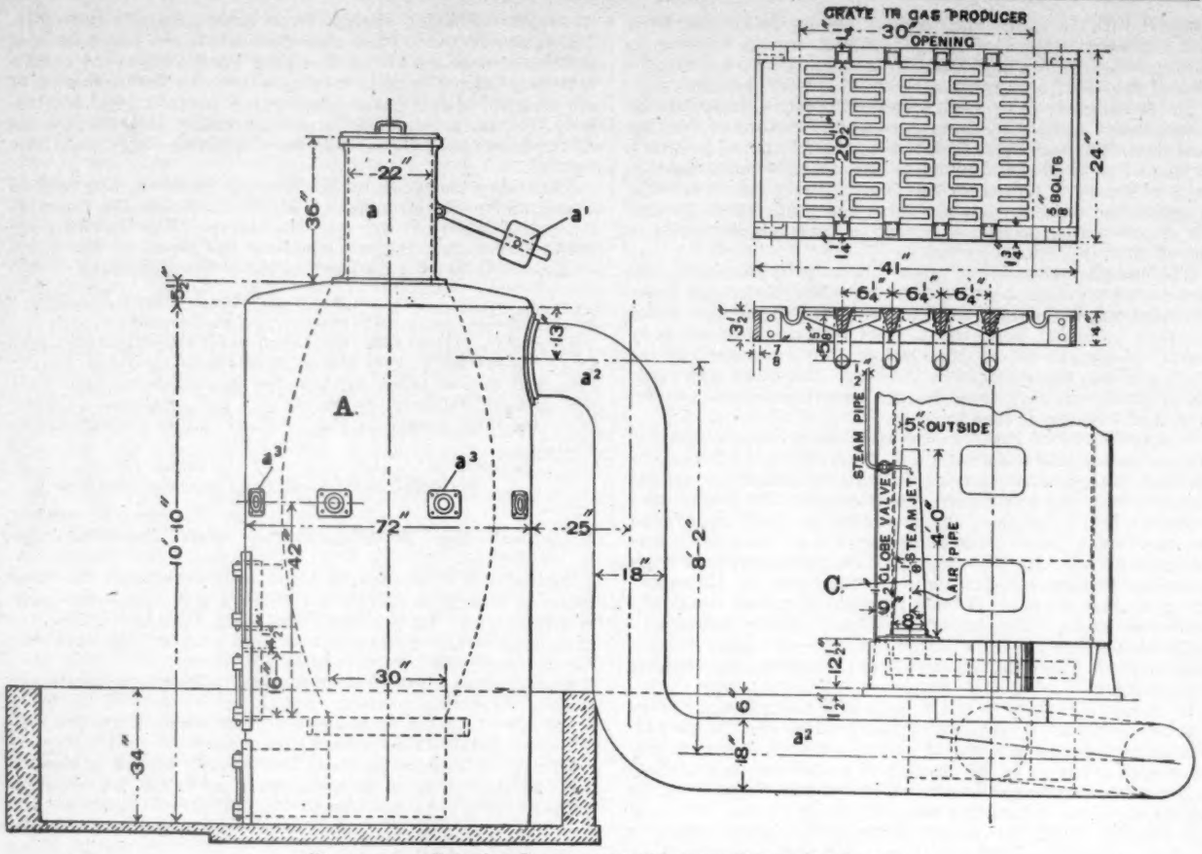
Carbon Hill coal gave much trouble, owing to difficulty in keeping the mass in producer from getting intensely hot. The gas convey pipe was red hot most of the time. To avoid this tendency the production of gas was "dragged," often to the extent of diminishing steam pressure in boiler. This again required the cutting in of other boilers to supply the deficiency, and accounts for a larger proportion of time during tests with this fuel in which the boiler was aided as shown. The accumulation of ashes, coke and clinker with Carbon Hill was also a source of midnight delay.

Using Nanaimo coal, the producer gave no great trouble with overheating of the mass. The quantity of ash and clinker were not sufficient to require cleaning out during period of each 12 hours' test with this fuel. Steam pressure was not always up to standard, but the proportion of time the boiler required aiding was small compared with the previous fuels tested, as will be seen.

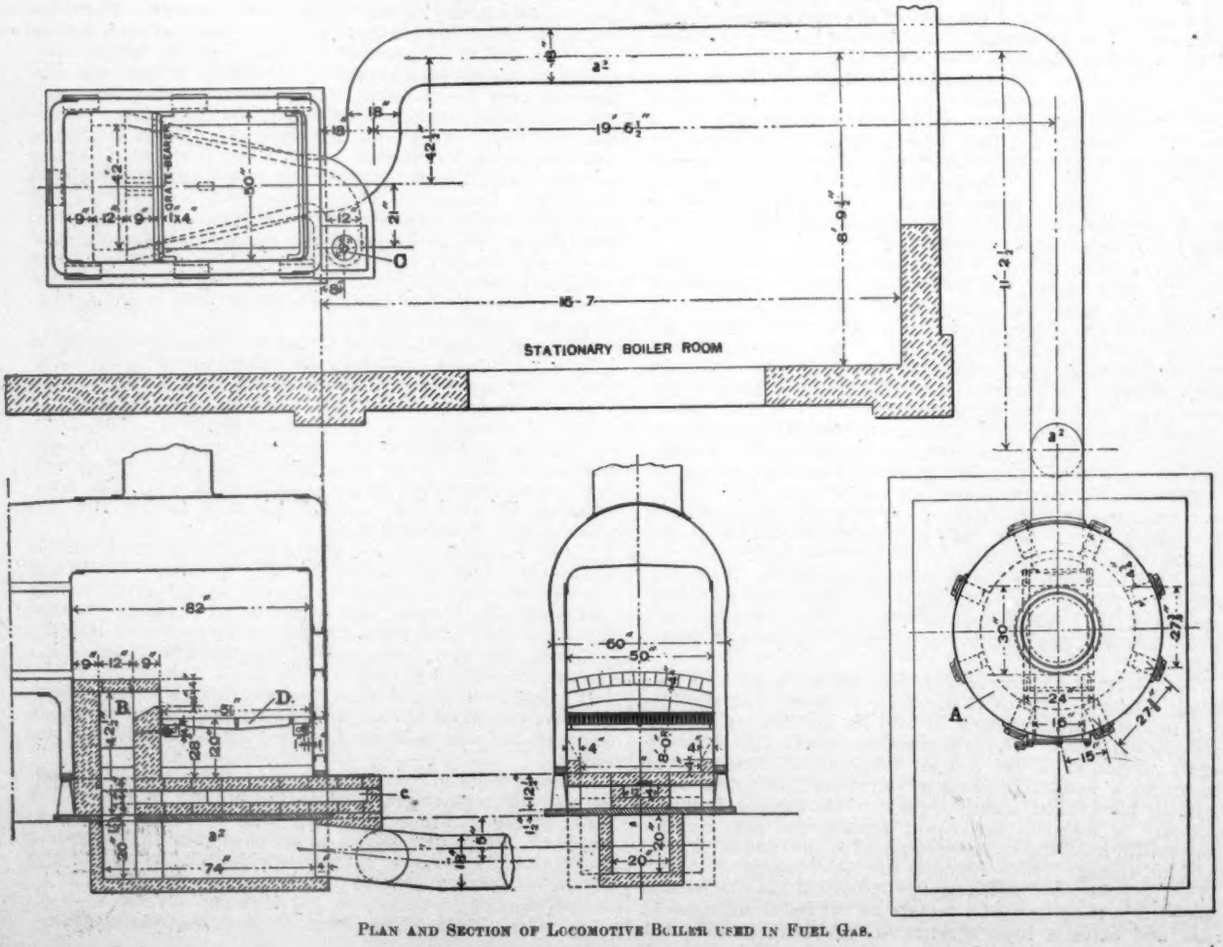
It would seem to have been shown by the tests that the producer as constructed (blue print of arrangement of which accompanies report) was not large enough to supply this size boiler.

On completion of tests with gas producer, it was disconnected and the regular grates placed in fire-box of boilers. A series of tests was then made with same fuels burned in usual manner. The figures shown in attached tabulated statement are totals and averages of three tests with each fuel and method of combustion, a total of 36 tests having been made.

(Signed) HOWARD STILLMAN,
Engineer of Tests.



ELEVATION OF FUEL GAS PLANT OF THE SOUTHERN PACIFIC RAILROAD.



PLAN AND SECTION OF LOCOMOTIVE BOILER USED IN FUEL GAS.

EXPERIMENTS ON THE SOUTHERN PACIFIC RAILROAD.

A description of the apparatus is here necessary to understand the tabulated report of Mr. Stillman.

The gas producer *A* was of the ordinary pattern, fitted with a shaking grate-bar such as is used in locomotives. Two steam-jet pipes (not shown) were arranged to the right and left

It is not uninteresting to note that the method of arranging the combining chamber behind the bridge wall is one applicable to most any boiler, and that, as the grate bar is not disturbed, either method of firing can be adopted according to the time the boiler is to be run.

COMPARATIVE TEST WITH FUELS IN GAS PRODUCER CONNECTED TO STATIONARY BOILER AND BURNED ON GRATES OF SAME BOILER IN USUAL MANNER, BOILER SUPPLYING STEAM FOR ELECTRIC LIGHT ENGINE ONLY.

SACRAMENTO SHOPS, FEBRUARY, 1895.

Kind of coal	Ione.		Carbon Hill.		Nanaimo.	
Method of combustion	In Producer.	On Grates.	In Producer.	On Grates.	In Producer.	On Grates.
Dates of test	Dec. 6, 7, 8.	Jan. 21, 22, 23.	Dec. 13, 14, 15.	Jan. 24, 25, 26.	Dec. 18, 19, 20.	Feb. 6, 7, 8.
Galls. water evaporated	9,280	9,475	6,200	10,090	9,834	10,634
Lbs. " "	76,704	78,927	51,648	84,050	81,940	88,582
" coal burned	29,440	33,060	9,000	13,790	11,200	14,888
Average steam pressure	63.4 lbs.	63.4 lbs.	60.0 lbs.	68.7 lbs.	64.4 lbs.	75.7 lbs.
" temperature in smoke-arch of boiler	460° F.	503° F.	475° F.	551° F.	518° F.	515° F.
Temperature feed water	58° F.	49° F.	48.6° F.	47° F.	50° F.	49° F.
Evaporation:						
Lbs. water to lb. coal	2.61	2.40	5.74	6.09	7.31	5.95
Equivalent evaporation from and at 212°	3.10	2.88	6.89	7.21	8.77	7.16
Duration of test	36 hours.	36 hours.	36 hours.	36 hours.	36 hours.	36 hours.
Percentage of above time during which the boiler was able to maintain steam pressure unaided by other boilers (above 40 lbs. required)	73 6 per cent.	100 per cent.	45.3 per cent.	100 per cent.	98.4 per cent.	100 per cent.
Lbs. water evaporated per sq. ft. heat surface	80.0	81.6	54.6	87.1	86.5	90.5
Cost per 1,000 galls. of water evaporated	$2.38	$2.60	$3.77	$3.54	$3.01	$3.64
Per cent. saving in cost per 1,000 galls. of water evaporated	8.4 per cent.			6.5 per cent.	17.3 per cent.	
Cost of coal per ton	$1.50		$5.20		$5.20	

of the ash-pit and cleaning doors of the producer, with valves regulating the supply of steam in the jets, and thus the supply of air entering the burning mass of coal *via* the ash-pit.

The coal was fed into the producer by the hopper *a* arranged with the usual cone valve and counter-weight a^1; the products of combustion escaped through the outlet pipe a^2 to the combining chamber *B* back of the bridge wall. Peep-holes a^3 were arranged in the outside of the producer at intervals to admit of a bar to break up clinkers.

Air was admitted or rather forced through the steam-jet pipe *C* into the passage *c*, where it met and intermixed in the combining chamber *B* with the hydrocarbon gases from the producer.

A fire was ignited upon the grate *D*, and, in addition to raising the steam to a starting-point, served to light the product from the producer when the same was rich enough for combustion, after which it was allowed to die out.

The result of the tests, and particularly the 17-per-cent. increase in the performance of the Nanaimo coal, as shown in the table, are not by any means unsatisfactory, especially when it is considered that the boiler was not the one best adapted to the tests, being of the locomotive pattern, originally intended for a river steamer. More satisfactory results would undoubtedly have been had with a boiler of the return tubular type, for then the hot gases would have had opportunity to expand and develop their greatest heat in the combustion chamber behind the bridge wall before final extinguishment in the tubes. With the combining chamber arranged as shown, in a boiler other than one of the locomotive pattern (which in this instance seriously cut down the heating area of the fire-box), a fire could also have been kept up upon the grate bars when the producer was not in use or during the period of its cleaning.

A better and a more economical result would also have followed the use of dry air, such as could have readily been had from the forge blast near by, instead of the forced draft of moist air through the steam jet pipe *C*.

The particular use to which the boiler was put—that of running an electric plant—made it difficult, with only one boiler, to properly clean out the producer at the time it became necessary without a loss in the average steam pressure, and a resultant falling off in the showing of the evaporation of water. Carbon Hill coal, however, has always shown a tendency to clinker; while the difficulty with the accumulation of ashes from the Ione coal will be understood when it is stated that its evaporative efficiency, when compared to Nanaimo, is as 1 to 3, so that in bulk three times as much would have to be used. (See table of analysis of coals.)

It will be noted, from Mr. Stillman's report, that the person in charge of the plant was the ordinary fireman. Usually tests like that described are either conducted under the supervision of an enthusiastic inventor or the watchful eye of a mechanical engineer, and the results obtained by them experimentally are seldom equalled in practice.

The report of Mr. Stillman does not state that the operation of the boiler was smokeless; nor could that fact have been readily determined, for the boiler was one of a series using a common stack. That the producer method of firing a boiler, however, *is* smokeless is a fact so well known that the statement in itself is superfluous.

ANALYSIS OF THE COALS TESTED.

(From S. P. Co.'s Analysis of Pacific Coast Fuels.)

	Ione.	Carbon Hill.	Nanaimo.
Moisture	42.58	2.16	2.25
Volatile matter	34.88	31.73	36.05
Fixed carbon	17.42	55.80	51.95
Ash	5.12	10.31	9.75
Total	100.00	100.00	100.00

THE MASTER CAR-BUILDERS' CONVENTION.

THE twenty-ninth annual convention of the Master Car-Builders' Association was called to order in the Opera House, Thousand Islands, Alexandria Bay, N. Y., on Tuesday morning, June 11, 1895, at nine o'clock by the President, Mr. John S. Lentz, who is the Master Car-Builder of the Lehigh Valley Railroad.

After the speech of welcome with which it is customary to open these proceedings, the President read his annual address, which was followed by the routine business of the Secretary's and Treasurer's reports, appointments of committees, etc. Then came the report on the interchange of cars. The report was a practical recommendation of the Chicago agreement,* with such few modifications as have been suggested by the experience of the past few months. This report was signed by Messrs. Leeds, Marden, Irwin and Barr. Mr. C. D. Nelson submitted a minority report taking exception to the statements of the majority, and arguing that the rules were satisfactory and efficient as they stand. In the discussion that followed there was much said in favor of the smooth working of the Chicago agreement; but even those speakers who are personally known to be the most enthusiastic over it, advised moderation and the postponement of any decisive or radical action for another year, and this is practically what was done when the matter was put to vote, after which there followed the usual detailed modification of the rules.

The opening of the Wednesday morning session was varied by the presentation of an exceedingly handsome badge to each of the past presidents of the Association, who are Messrs.

* See AMERICAN ENGINEER AND RAILROAD JOURNAL, January, 1895.

I. W. Van Houten, F. D. Adams, M. C. Andrews, William McWood, John Kirby and E. W. Grieves.

The reports of the two committees on brake-shoe tests are the most interesting and valuable that came before the convention. The Committee on Laboratory Tests presented a continuation of the report of last year, and while they have obtained a great mass of information, they do not feel warranted in making any recommendations as yet, but publish tables in which it is shown that, at a speed of 40 miles per hour, the coefficient of friction between a soft cast-iron shoe and a chilled wheel averages about 28 per cent., varying between 28.8 per cent. at the first application and 39.8 per cent. at the end. At 65 miles per hour these figures become 13.4 per cent. for the average, and range from 13.9 per cent to 20.5 per cent. At 65 miles per hour, and a steel-tired wheel, the figures are 8.9 per cent. for the average, ranging from 9.5 per cent. to 7.2 per cent. The report of the Committee on Road Tests enters into a detailed statement of the work done by them, and of which we give the following abstract.

ROAD TEST OF BRAKE-SHOES.

The general committee of twelve appointed by the Association (at its annual convention of 1893) to organize and conduct a series of service tests of brake-shoes, made a preliminary report (by its executive committee of three) at the convention of 1894. In that preliminary report it was stated that of the 12 railroad companies represented by the membership

STATEMENT OF BRAKE-SHOES USED IN SERVICE TESTS.

Kind of Shoe.	Made by	Address.	Number of Shoes on Cast-Iron Wheels.	Number of Shoes on Steel-Tired Wheels.	Total Number of Shoes Used in Test.
A. Soft cast iron	Pennsylvania R. R. Co.	Altoona, Pa.	Enough to wear out all the others.		
B. Hard cast iron	Ramapo Wheel & Foundry Co.	Ramapo, N. Y.	24	16	40
C. Soft open hearth steel	Solid Steel Co.	Alliance, Ohio.	28	20	48
D. Hard open hearth steel	" " "	" "	28	20	48
E. Malleable iron	Dayton Malleable Iron Co	Dayton, Ohio	28	16	44
F. Special S. T. malleable iron	" " " "	" "	24	20	44
G. Special C. W. malleable iron	" " " "	" "	28	16	44
H. Congdon	The Sargent Co.	Chicago, Ill.	28	12	40
I. Meehan	" "	" "	28	20	48
J. Lappin	Lappin Brake-Shoe Co.	New York City	24	24	48
K. Safety	Safety Brake-Shoe Co.	Boston, Mass.	24	20	44
L. Soft steel (pressed)	Schoen Manufacturing Co.	Pittsburg, Pa.	24	20	44
M. Wrought iron (pressed)	" "	" "	16	16	32
N. Sargent special	The Sargent Co.	Chicago, Ill.	28	16	44
Total (except the "A" soft cast iron shoes)			332	236	568

SERVICE TEST OF BRAKE-SHOES.

Condensed Statement of Results for Brake-Shoes Used on Chilled Cast-Iron Wheels.

1. Kind of Shoe.	2. Made by	3. Wear by Weight Relative to Soft Cast Iron for Same Service.	4. Net Cost Per lb. of Metal Worn, in Cents.	5. Relative Cost for Same Service, in Cents.	6. Cost Relative to Soft Cast Iron for Same Service.	7 Remarks.
A. Soft cast iron	Pennsylvania R. R. Co.	1.00	2.08	2.08	1.00	
B. Hard cast iron	Ramapo W. & F. Co	.86	2.81	2.41	1.16	Wear irregular.
C. Soft O. H. steel	Solid Steel Co.	.17	7.65	1.30	.62	" "
D. Hard O. H. steel	" " "	.10	7.65	.76	.36	Worn out.
E. Malleable iron	Dayton Malleable Iron Co.	.53	2.37	1.25	.60	" "
F. Special S. T. malleable iron	" " " "	.83	2.37	1.97	.94	" "
G. Special C. W. malleable iron	" " " "	.83	2.37	1.97	.94	Wear irregular.
H. Congdon	The Sargent Co.	.31	3.06	.95	.45	" "
I. Meehan	" " "	.21	6.70	2 08	1.00	" "
J. Lappin	Lappin Brake-Shoe Co.	.55	5.41	2 98	1.45	" "
K. Safety	Safety Brake-Shoe Co.	.70	3.65	2.56	1.23	Wear irregular and plugs fell out.
L. Soft steel (pressed),	Schoen Manufacturing Co	.11	5.63	.62	.30	Cut surface of wheel.
M. Wrought iron (pressed).	" " "	.11	5.78	.64	.31	Worn out.
N. Sargent special	The Sargent Co.	.22	4.80	1.06	.51	Metal pieces fell out and broke.

SERVICE TEST OF BRAKE-SHOES.

Condensed Statement of Results for Brake-Shoes Used on Steel-Tired Wheels.

1. Kind of Shoe.	2. Made by	3. Wear by Weight Relative to Soft Cast Iron for Same Service.	4. Net Cost Per lb. of Metal Worn, in Cents.	5. Relative Cost for Same Service, in Cents.	6. Cost Relative to Soft Cast Iron for Same Service.	7. Remarks.
A. Soft cast iron	Pennsylvania R. R. Co.	1 00	2.08	2 08	1.00	
B. Hard cast iron	Ramapo Wheel & Foundry Co.	1.06	2.81	2.98	1.43	Worn out.
C. Soft O. H. steel	Solid Steel Co.	.42	7.65	3.21	1.54	Very hard on tires.
D. Hard O. H. Steel	" " "	.31	7.65	2.37	1.14	Tires very badly worn.
E. Malleable iron	Dayton Malleable Iron Co.	.51	2.37	1.21	.58	Worn out.
F. Special S. T. malleable iron	" " " "	.67	2 37	1.59	.76	" "
G. Special C. W. malleable iron	" " " "	.81	2.37	1 92	.92	Wear irregular.
H. Congdon	The Sargent Co.	.30	3.06	.92	.44	Worn out.
I. Meehan	" " "	.21	6.70	1.41	.68	" "
J. Lappin	Lappin Brake-Shoe Co.	.35	5.41	1.90	.91	Wear irregular.
K. Safety	Safety Brake-Shoe Co.	.77	3.65	2.81	1.35	Shoes cracked and plugs fell out.
L. Soft steel (pressed)	Schoen Manufacturing Co.	.29	5.63	1.63	.78	Cut the tires very badly.
M. Wrought iron (pressed)	" " "	.29	5.78	1.68	.81	Wear irregular and very hard on tires.
N. Sargent special	The Sargent Co	.33	4.80	1.58	.76	Metal pieces fell out and wear irregular.

of the original general committee of twelve, five (the Pennsylvania, the New York Central, the Northern Pacific, the Chicago & Alton, and the Central Railroad of New Jersey) had subsequently declined to participate in the tests. The railroads represented by the other seven members of the original general committee of twelve (the Fitchburg, the Chicago, Burlington & Northern, the Chicago, Burlington & Quincy, the Chesapeake & Ohio, the Lake Shore & Michigan Southern, the New York, Lake Erie & Western, and the Norfolk & Western) have, however, conducted a series of such service tests.

Each car under test had one truck equipped with soft cast-iron brake-shoes (all of which were made at the foundry of the Pennsylvania Railroad Company at Altoona, Pennsylvania), the other truck of each car being equipped with an outfit of some one of the 13 different kinds of special brake-shoes which are included in the test; the brake-shoes (including the soft cast-iron reference shoes) used being as given on page 306.

The equipment used by the different railroad companies in these service tests of brake-shoes has been as follows:

STATEMENT OF EQUIPMENT USED IN SERVICE TESTS OF BRAKE-SHOES.

Railroad Company.	Kind of Equipment.	With Cast-Iron Wheels.	With Steel-Tired Wheels.	Total Equipment.
Fitchburg	Pass. Equipt. Cars	..	11	11
C. B. & N.	" " "	13	4	17
C. B. & Q.	" " "	13	13	26
C. & O.	" " "	8	5	13
L. S. & M. S.	" " "	12	13	25
N. Y., L. E. & W.	Locomotive Tenders.	13	13	26
N. & W.	Pass Equipt. Cars.	12	..	12
Total		71	59	130

Both of the above statements differ slightly from the corresponding statements given in the preliminary report of last year. This is partly owing to the fact that some of the railroad companies were not able to put in the exact amount of equipment originally promised, and partly due to the further fact that some of the returns made by the railroad companies had to be rejected on account of being incomplete or evidently incorrect. In still other cases, the same equipment was used for testing different kinds of shoes. The cast-iron wheels under the test equipment were principally 33-in. wheels; the steel-tired wheels were quite evenly divided between 33-in., 36-in., and 42-in.

In the preliminary report of last year the Committee pointed out that while the original intention was to calibrate the brake-beam release springs under each car used in the test, that plan was subsequently abandoned on the theory that a sufficient number of shoes of each kind were to be tried to get fair average results, under which circumstances the differences in the resistance offered by the brake beam release springs under different cars might be disregarded. In working up the results of the tests this year, the Committee concluded that they could also entirely disregard the question of brake leverages, owing to the fact that it seemed entirely safe to assume that on every car used in the test, the leverages and brake-beam pressures were the same on both trucks.

The results of the test for each variety of brake-shoe, expressed in wear, by weight, relatively to the wear of soft cast-iron (A) reference shoes, are embodied in the following statements. (In computing the average relative wear of all brake-shoes of one kind, the relative wear of brake-shoes used in Norfolk & Western equipment was doubled, owing to the fact that each Norfolk & Western truck was equipped with eight brake-shoes, whereas each truck on all other railroads was equipped with but four brake-shoes.)

Then follows a detailed statement of the results obtained with each type of shoe as compared with the soft cast-iron shoes that were taken as the standard.

In computing the relative service cost of these several brake-shoes which were under test, it was necessary to work out the actual net cost of the metal worn off. The reports from different railroad companies show that the scrap weight of brake-shoes of all kinds tested vary but little from an average of about 10 lbs. The method followed in computing the service cost was to take the weight and cost of one shoe new, and the weight and value of one shoe as scrapped; the difference in weights representing the metal worn off in service, the difference in the values representing the net cost of that metal, and the quotient arising from the division of one quantity by the other representing the net cost per pound of the metal worn off in service. The Committee obtained from each manufacturer his statement of the present selling price and scrap value of brake-shoes of his make. As the selling prices thus given by the manufacturers were, in several cases, regarded as confidential, the Committee have not thought it advisable to reproduce them in this report. The final results derived from these computations are given in the following tables:

WEIGHTS AND VALUES OF BRAKE-SHOES.

Kind of Shoe.	Made by	Weight of one Shoe.		Wearing Weight.	Net Cost of Metal Worn.	
		New	Scrap		Per Shoe.	Per Lb.
		Lbs.	Lbs.	Lbs.	Cts.	Cts.
A. Soft cast iron	Penn. R. R. Co.	23.0	10.0	12.0	25.0	2.08
B. Hard cast iron	Ramapo Wheel & Foundry Co.	23.5	10.0	13.5	35 2	2.81
C. Soft O. H. steel	The Solid Steel Co.	23.0	10.0	13.0	99.5	7.65
D. Hard O. H. steel	" " " "	23.0	10.0	13.0	99.5	7.65
E. Malleable iron	Dayton Mal. Iron Co	22.6	10.0	12.6	29.8	2.37
F. Special S. T. Mal. iron	Dayton Mal. Iron Co.	22.6	10.0	12.6	29.8	2.37
G. Special C. W. mal. iron	Dayton Mal. Iron Co.	22.6	10.0	12.6	29.8	2.37
H. Congdon	The Sargent Co.	22.2	10.0	12.2	37.4	3.06
I. Meehan	" " "	22.2	10.0	12.2	81.8	6.70
J. Lappin	The Lappin Brake Shoe Co.	23.3	10.0	13.3	72.0	5.41
K. Safety	The Safety Brake Shoe Co.	19.1	10.0	9.1	33.2	3.65
L. Soft steel (pressed)	Schoen Mfg. Co.	20.0	10.0	10.0	56.3	5.63
M. Wrought Iron (pressed)	" " "	19.5	10.0	9.5	55.0	5.78
N. Sargent Special.	The Sargent Co	22.8	10.0	12.8	61.4	4.80

The final results in condensed form are given by the following statements, which show the cost (of each variety of brake-shoe) relatively to the net cost of soft cast-iron brake-shoes for the same service; the results of the tests of brake-shoes used against cast-iron wheels and used against steel-tired wheels being shown separately.

The entries in column 3 are simply the averages which appear in the footings of the detail statements given above. The entries in column 4 are taken from the last column of the statement entitled "Weights and Values of Brake-Shoes." The entries in column 5 are the product of the entries in columns 3 and 4. The entries in column 6 are simply the entries of column 5 expressed in ratios relatively to the same value for soft cast iron taken as unity. The entries in column 7 are transferred from the footings of the columns headed "Remarks" in the detail statements given above. The term "Worn Out" indicates that according to the reports, the shoes were worn down to a minimum of thickness and weight without serious trouble from breakage. The term "Wear Irregular" indicates that some shoes wore out before others of the same kind, suggesting a want of uniformity in the metal of which the shoes were made.

In considering the condensed statements of results as last above given, it should be borne in mind that the figures simply show the relative cost of different kinds of brake-shoes when subjected to the same service, but that the actual relative economic value of different kinds of brake-shoes can be determined only by combining the ratios above given with corresponding ratios, which will express the relative amount of friction produced by the application of these several varieties of brake-shoes under the same conditions. It is expected that the Committee on Laboratory Tests of Brake-Shoes will inform the Association on this point.

In the discussion Mr. Waitt said "that the committee have stated that it was not deemed advisable, owing to some practical difficulties, to make a determination as to the effect of the brake shoes on the tire of the wheels. Many of the indicators or gauges for determining or indicating the wear on tires and wheels are difficult to use or expensive. In the work that was done by the Lake Shore & Michigan Southern Road, it was determined that we would try to get as accurate an indication as possible as to what the effect was of the brake shoes on the chilled wheels and also on the steel tires. We found quite a simple and accurate method of doing this, which I would like to present to the convention, together with the data that we obtained, as such data surely has an important bearing on the question of the use of different kinds of brake shoes. Instead of using anything in the way of a gauge which might show by means of a pencil the contour of the wheel

tread, we adopted a form of flask, of which I have some blue prints and sample. The general outline is that of the tread of the wheel.

"This flask is placed over the wheel at a point which we indicate with a prick punch mark, and flask is filled with quick setting plaster of Paris, the wheel being greased so that the plaster will not stick to it. Then these casts which are in the form are labelled, indicating the number of the car and the number of the wheel and kind of shoe, etc. After the special shoes were worn out, we took a second cast, and when any changes were made we also took some casts of the wheels that were removed, and also the wheels that were applied at a similar point; making diagrams from these plaster Paris casts both before and after, we get a result, which shows something like this: the black lines on the various diagrams show the original shape of the wheel; the red lines indicate the shape of the tread of the wheel after the service; and from this we are able to judge of the comparative wearing effect of the different metals on the wheels; these are not found to be entirely in accordance with the friction. Sometimes it has been said that the shoes which will last the longest will wear the wheel the most. That was not found to be the case, the friction and the wearing properties of the shoes not being in any regular ratio. Believing that it would be interesting to the members to have this data, I will be glad to turn the diagrams over to the Secretary, if you desire to reproduce them, so that you can see what the comparative wearing qualities of the various shoes are."

The following statement was submitted by Mr. Waitt:

"It is found that the wear of the following special shoes is about equal to the wear in the same time of soft cast-iron shoes: Cast-steel shoe B, on steel wheels; Meehan shoe I, on cast wheels; malleable shoe G, on steel wheels; malleable shoe G, on cast wheel; safety shoe K, on steel wheels; safety shoe K, on cast wheels; Congdon shoe H, on cast wheels; Sargent shoe N, on cast wheels; malleable shoe F, on cast wheels; malleable shoe F on steel wheels; Lappin shoe I, on cast wheels; Sargent shoe N, on steel wheels; malleable shoe E, on steel wheels.

"With the balance of the shoes the result was that wrought-iron shoe M, on cast wheels, more wear with special shoe and the tread of wheels badly grooved. The same shoe on steel wheels, wear on tread of steel wheels three times as much as the cast iron. The Schoen pressed-steel shoe L, wore the cast-iron wheels slightly less than the common cast-iron shoe, but on steel wheels wore the tire about 50 per cent. more. Soft open-hearth steel shoe C, on steel wheels, wore four times as much as with special shoes. Lappin shoe on steel wheel 50 per cent. more wear with special shoe. Open-hearth steel shoe D, the same. Wrought-iron shoe M, on steel wheel, wore three times as much. Meehan shoe I, on steel, wore double as much as the soft iron; the same with Congdon shoe on steel."

The Committee on the Lubrication of Cars presented a report that consisted for the most part of a *résumé* of the attempts that have been made at oil testing, and an abstract of a paper by Professor Denton on the subject that was read before the American Association for the Advancement of Science. The discussion was of a desultory character, but may be summed up in the statement that oil can be best saved by paying careful attention to its use and seeing that it is not wasted.

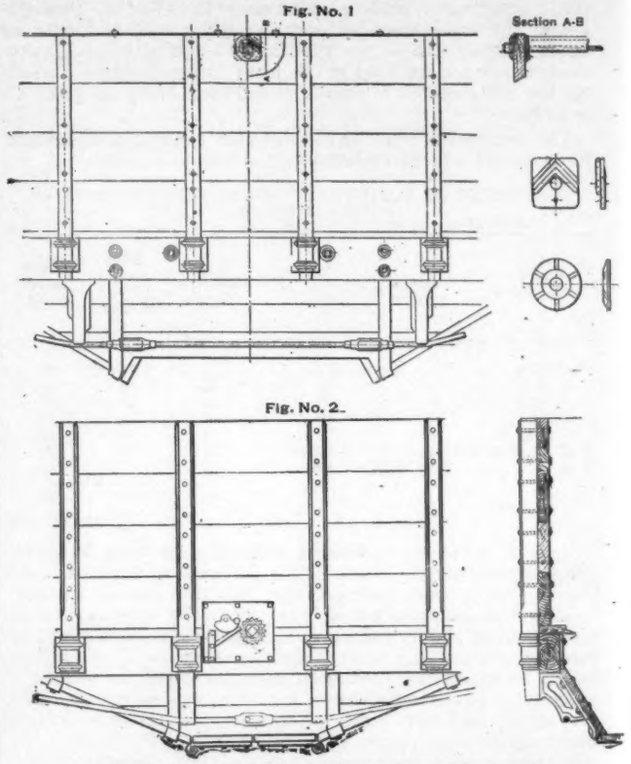
The report of the Committee on Air-Brake Tests will be of especial value to those intending to come upon the market with a new brake, by informing them of the conditions with which they must comply. Speaking of these recommendations, it was said that in recommending standard requirements this report was not recommending any one particular triple. If it is adopted as a standard, it does not compel any railroad to buy any particular triple, as out of the four tested during the past year at Altoona there was not one that could not be made to fulfil the requirement. The report on air-brake and hand-brake apparatus consisted in the presentation of a few dimensions, and the statement that there was no demand for standards in this particular, which seems to be the opinion of the convention, as the report was received and the committee discharged. The report on the strengthening of passenger car ends considered it unwise and impracticable for the Association to take any action at present, as details have not been properly worked out. There was some objection in the discussion to increasing the weight of cars for the purpose of strengthening the ends, and the Government designs, where the platforms are vestibuled and the spaces used for closets and wash-rooms, was severely criticised.

The last report presented was that on coal car sides, of which we give an abstract with the accompanying illustrations.

COAL-CAR SIDES.

Your Committee has carefully considered the methods of staying the sides of 60,000 lbs. capacity coal-cars with high sides, and is of the opinion that the most economical and efficient methods of staying the sides of these cars is by the use of a transverse tie-rod, near the top, protected by an angle iron, as shown in fig. 1.

Whenever, however, this construction is prohibited, on account of the cars being used at times to carry lumber and other lading with which this cross member would interfere, your Committee would recommend extending two stakes on each side and near the middle of the car, below the side sills and supporting them by castings having a bearing against the sides of the hopper bottoms, as shown in fig. 2, or some equivalent construction.



METHOD OF STRENGTHENING COAL-CAR SIDES.

In connection with this latter arrangement, it is desired to call attention to the fact that when the car is loaded, the weight of the lading in the hopper bottom will assist in keeping these castings out to their proper position.

Your Committee would further recommend that stakes be made as deep as practicable, and that they be spaced closer together near the middle than toward the ends of the car; also, that stake pockets be put on with a little draw, when the stakes are new, so that they can be tightened to follow up the shrinkage of the stakes.

Several devices for staying the sides of these cars have been patented, some of which have been used on a large number of cars and possess more or less merit, but your Committee has failed to discover that any of them are superior to the two methods above mentioned.

In the discussion it was the prevailing opinion that the cross-tie at the top is the only satisfactory method of tying high-side coal cars. Experience has shown that it is impracticable to keep the side truss up in proper shape, and that when loaded the sides will bulge.

Just before adjournment the Executive Committee recommended that the standard size of postal-cards be changed from $3\frac{1}{2} \times 5\frac{1}{2}$ in. to $3\frac{3}{4} \times 6\frac{1}{4}$ in., to conform to the new style adopted by the United States Government. Then, after the usual series of resolutions, in which thanks were extended to all who had rendered any courtesies to the members of the convention and their friends, the annual election of officers was held, which resulted as follows: President, John S. Lentz; First Vice-President, S. A. Crone; Second Vice-President, E. D. Bronner; Third Vice-President, J. C. Barber; Treasurer, G. W. Demarest. New members of the Executive Committee, R. H. Soule, H. S. Hayward, A. E. Mitchell. Finally, after an informal vote, by which it appeared that there was a preponderance of opinion in favor of Niagara Falls as the next place of meeting, the convention adjourned *sine die*.

BOILERS AND VESSELS OF WAR.

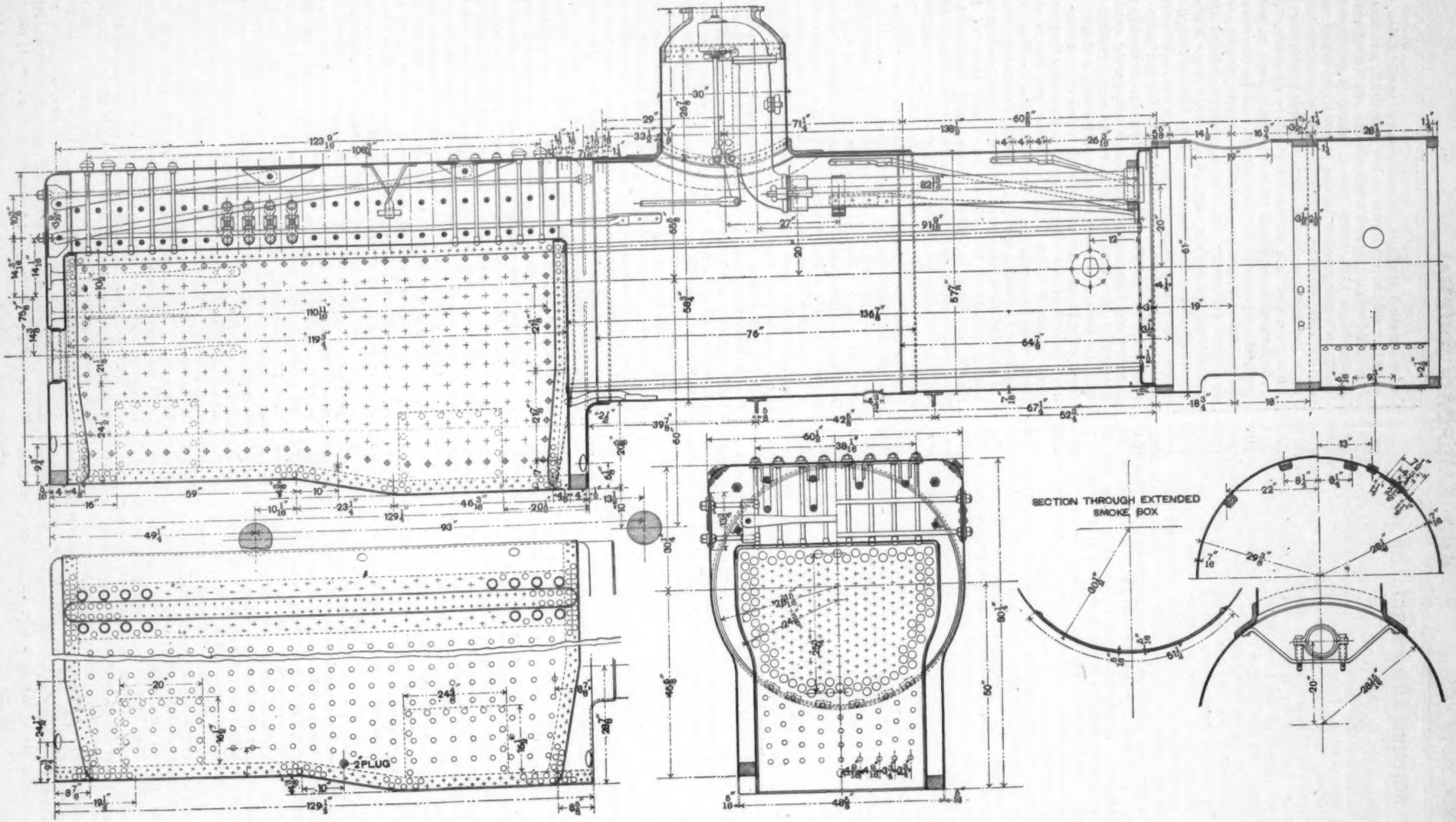
In our issue for May we published, at some length, a report of the discussions that have taken place in Parliament regarding the introduction of the water-tube boiler into the vessels of the British Navy, and the conclusion that the reader must reach therefrom is that there is a large number of persons in the country who do not approve of the course of the Admiralty in the matter of the introduction of these boilers. It is very evident from the articles that are continually appearing in the technical press of Great Britain that many engineers take exceptions to the Navy as it exists, and their criticisms frequently assume such a form that it must be embarrassing for the Admiralty to frame a suitable reply, and one which will be convincing and satisfactory. Sometimes these criticisms take the form of a story, as in the "Cruise of the Mary Rose," which was published in the *Engineer* some time ago; at others it appears in the shape of letters to the editor. These letters frequently show the touch of a master hand, and no one can read them without being convinced that the writer is thoroughly familiar with the subject that he has in hand. Such a series of letters appeared in the *Engineering* a short time ago under the *nom de plume* of "Argus."

Argus takes the position that the great mistake made by the Admiralty in the construction and arrangements of the vessels for the Navy lies in the cutting down of the boiler capacity. He says that "a ship on her measured mile trials is under conditions that never can be secured on ordinary service; then it is matter chiefly of engine power, but the ability to follow up an enemy for a considerable time, and then engage him with the knowledge and confidence that the ship's reputed speed is at command, is a question of boilers." The writer then goes on to review the gradual increase in speed that vessels of war have undergone during the past thirty-five years, during which it has risen from 14 knots to 21. He makes the especial point of his attack the inference drawn in a paper read at the Royal Institution by Dr. White, that modern ships have had to be made very much larger and heavier to allow for space and weight for the large machinery necessary for modern speeds. This, the writer asserts, is not true even approximately. "For a very moderate amount of research demonstrates that while the dimensions and displacements of both battleships and cruisers have increased enormously under the *règime* of Dr. White, the weights and spaces allotted to propelling machinery are actually less than in the era he compares with his own—less absolutely, very much less comparatively to the ship's dimensions."

Reviewing the construction of individual vessels, Argus calls attention to a comparison that has been made by Dr. White between the *Alexandra* on trial, and the run of the *Royal Sovereign* from Plymouth to Gibraltar, adding that the comparison can be extended to advantage. The engines of the *Alexandra* are of the three cylinder compound type. "The *Royal Sovereign* is 55 ft. longer and 11½ ft. broader than the *Alexandra*, and on this occasion had 5,000 tons greater displacement. That a so much larger and heavier vessel should be propelled at the same speed with less H.P. is a subject that I do not propose to discuss; but the fact remains that not only was no part of this 5,000 extra tons weight, and the corresponding internal capacity allotted to propelling machinery, but, under both heads, there was a reduction as compared with the older and smaller ship—a deduction of about 300 tons in weight, and a reduction in stokehold space equivalent to the substitution of four 15 ft. 3 in. shells for six 11 ft. 10 in. ones. Clearly, then, whatever the reasons for the greater size of the new ship might be, the provision of more weight and space for the propelling machinery was not among them." In an account that is given of the re-engining of the *Thunderer* the crux of the whole matter is shown. The old machinery weighed 1,050 tons, and the new under 800 tons; the former coal supply was 1,350 tons. The new engines are so much more economical that 950 tons of coal give the same radius of action as formerly, so that the coal and machinery together save 650 tons, which, as the author says, *can be applied to other purposes*. In point of fact the engineer is deprived of all share in the benefits accruing from his own forward progress. As soon as an improvement is made, the constructive department swoops down and appropriates it, as often as not exaggerating the saving to be made, and leaving both the engineer and the naval officer, who would like a speedy ship, in a worse plight than before. Surely some part of the saving due to engineering improvements might legitimately be applied to securing a sea speed having a nearer approximation to trial speeds than is now the rule, seeing that the difference between the two has been a standing complaint by the executive branch ever since we have had a steam navy. As each new ship is completed, or where several are built from the same specification, a representative ship is put down to her load draft, and then passed through a series of speed trials, carried out with great care by a number of men, every one of whom is an expert. The results are compared with the expectations based on model experiments, checked by the propulsive coefficients derived from the trials of earlier ships of, speaking generally, the same type, and then recorded for future reference. Between each successive series of trials an eye is kept to possible or probable engineering improvements, and in the next design these improvements are embodied to save weight and space for other purposes; but the experience derived from the actual steaming performances of the ships at sea is absolutely ignored, nothing but trial data being used for designing purposes. The Admiralty, in short, carry out a laboratory experiment on rather a large scale, with the perfectly natural result that the solution of the problems in steamship propulsion derived from such experiments are purely academical, not taking into account the personal and practical factors which so materially affect a ship's performances at sea. While these experiments are of no value to us as a means toward maintenance of our alleged naval supremacy, they are obviously of great value to foreign naval powers, as showing them what to avoid; a lesson all of the leading ones are learning and putting into practice with startling avidity."

In a later letter Argus makes a detailed comparison between certain vessels of the British Navy and those of Russia, France, and Italy, in which he shows that these countries are all devoting much more space to the boilers than is found in the English ships of corresponding size and armament. In reference to the ships of the American Navy he says: "Crossing the Atlantic we find that the Americans have adopted the precept laid down by Dr. Elgar in his paper on Fast Ocean Steamers. The author said, speaking of a large proportion of boiler power, 'The necessity for this is also well known. The best results upon short trials are obtained with large engines and small boilers, but the best results at sea are obtained with smaller engines and larger boilers. This is also an instance in which short trials fail as a standard of what can be done upon a long voyage at sea.' So the Americans put in rather larger boilers than we do, and rather smaller engines—that is, speaking generally. To secure a high speed on paper, their ships are tried at a so-called normal draft, with only a proportion of their load on board, and as the displacements published are usually those of this normal draft, the information is often misleading.

"Take the coast defence ship *Indiana*, one of a set of three sister ships. She combines the length of the *Nile* with the beam of the *Admirals*, and at 24 ft. draft has a displacement of 10,300 tons; but another 1,000 tons of coal and stores would put her down to 26 ft. draft, and then she would be simply a reduced *Royal Sovereign*, taking the mean draft and displacement of the latter ship on the trial run to Gibraltar. The speed of this run, 15 knots, was what the Americans required for a sustained sea speed in the *Indiana* class; and with 3,000 tons less displacement to drive, the *Royal Sovereign's* 8,000 H.P. would be more than ample for this speed. To provide a margin 9,000 H.P. was specified for, and to develop this power engines are fitted almost identical with those put in our *Apollo* class for 9,000 H.P. The boilers are four in number, double-ended, and in external dimensions and design generally almost identical with those in the *Blenheim*. If, then, the *Blenheim's* six boilers are good for 21,000 H.P., the *Indiana's* four boilers should be good for 14,000; but the Americans attempt no such folly. They are content, for 9,000 H.P. as a maximum, to put in boilers representing 87 per cent. of the capacity of those we put in the *Royal Sovereign* class for 13,000 H.P., and when used in conjunction with suitable engines, are ample for 15 knots, which Dr. White called an excellent result in the case of the latter ship; and there is no apparent reason why the *Indiana*, on a long run, should not be capable, if desired, of maintaining her position alongside of or ahead of the *Royal Sovereign*. The Americans, in fact, adopted that ratio of boilers to engines in this ship, which could have readily been adopted for our larger second-class cruisers. The larger American battleship, the *Iowa*, has very nearly the same dimensions as the *Tria Sviatitelia*, of Russia, and the *Jauréguiberry*, of France, and at 24 ft. of draft has a displacement of 11,240 tons. Loaded to 26 ft. she has nearly the same displacement as the Russian vessel and our *Nile;* and judging from what is said of her by English experts, she appears to be a very formidable fighting ship. Her engine power is calculated at 11,000, as much as ever could be realized in the *Nile* again, and her engines are much smaller than the *Nile's;* but she has just one-third more boilers, with similar furnaces, but placed in much larger shells, Commodore Melville being obviously alive to the vari-



BELPAIRE BOILER FOR CLASS P EXPRESS LOCOMOTIVE, PENNSYLVANIA RAILROAD.

ation in boiler design necessary for the safe and successful use of forced draft, a point that may possibly be studied at Whitehall some day. With three engines large enough for the power that could be developed in any of our later ships by their own staffs, even for a spurt, and boilers superior both in size and design, it seems as if she would be perfectly safe as against any British ship, if it was not convenient to fight.

"The Americans, with the *Alabama* in mind, have devoted serious attention to cruisers, with results of the first importance to us. One of these cruisers—the *New York*—is persistently referred to in this country as something between the *Blake* and the *Edgar*, an idea that is quite erroneous. As usually described, she is simply a reproduction of the *Blake*, floating at her normal, or trial, or, if you like, speed-premium-earning draft of 23 ft. 3 in., her displacement being 8,150 tons; but with the same coal on board as the *Blake* (1,500 tons) she draws about 25 ft. 4 in., and has the same displacement (9,000 tons), and the same coefficient of fineness as our ship at her load draft of 25 ft. 9 in. Like the *Blenheim*, she has two sets of triple-expansion engines* to each screw, and six double-ended boilers with 48 furnaces; but, unlike the *Blenheim*, the boilers are designed to permit the forced draft being used with confidence, and the engines bear some reasonable proportion to the steam-producing capacity of the boilers. The *Blenheim's* trial trip gave results unapproachable in the *New York*, but there is an end of the matter; for continuous sea steaming the advantage is with the American.

"The *Brooklyn* is a distinctly improved *New York*, with more boiler capacity, representing 50 per cent. more grate and heating surface than in our *Edgar* class, in larger and longer shells, and as a cruiser we have nothing to compare with her. Whatever power could be maintained on the *Nile* by her own staff, double that power could be maintained continuously in the *Brooklyn* by her own staff. Under all of the varying circumstances of the *Crescent's* late voyage to Australia and back, whatever power was maintained, 50 per cent. more could be maintained in the *Brooklyn*."

After making a similarly complimentary comparison in regard to the *Olympia* and the *Royal Arthur*, he continues in regard to the *Columbia* and *Minneapolis:* "Their normal draft is 22 ft. 6 in., with 7,350 tons displacement, but with 2,000 tons of coal on board, and an extra weight of 200 tons, they draw the same water as the *Blenheim*, 25 ft. 9 in., have 200 tons less displacement, and the same coefficient of fineness, and seeing that they are longer and narrower, are at least as easy forms to drive. The three engines have, collectively, the same cylinder areas as the *Blenheim's* four, and, therefore, running at the same piston speed under the same pressure, would give the same aggregate power. To supply steam the *Columbia* has six double-ended boilers, and in addition two smaller boilers, so that the *Columbia*, with at least as fine a form to drive, and the same engine power as the *Blenheim*, has all of the *Blenheim's* boiler power and some 3,500 H.P. in addition. The *Minneapolis* represents a still further advance, 14 per cent. being added to the grate and heating surfaces, as compared with the *Columbia*, which gives her just double the heating surface of our *Edgar* class. This ship, loaded to the displacement of the *Royal Arthur*, would have as much coal on board, her two side engines would indicate as much power as any two of the engines of the pattern and size of the *Royal Arthur's* have done on forced draft trials; and to supply steam there is practically double the *Royal Arthur's* boiler installation. How is this 'commerce destroyer,' then, to be destroyed? We have nothing to catch her now, and as to the *Powerful* and *Terrible*, they seem to be carricatures of the *Lepanto* or *Re Umberto*, with an extremely ill-advised experiment in boilers thrown in. Our cruisers are deprived of the one element absolutely necessary to their efficiency—namely, boilers for a high standard sea speed, in order to add something to them to increase their power as fighting ships, the result being that they will be forced to fight and probably sunk forthwith, under circumstances when, with adequate boilers, they could have escaped. Now the *Columbia* and *Minneapolis* have an amount of protection and armament which would render them formidable to an armed mercantile cruiser, but there is no inducement whatever held out to the commanders to risk their ship in an unequal encounter with a heavily armed or well-protected vessel. In the presence of a superior force they are to leave; and to secure the ability to do this the Americans have not begrudged a very large space for machinery, and a weight for it of about 2,000 tons."

The author apparently places very little confidence in the water-tube boiler as a solution of the difficulty, although he confines his actual criticism to those of the Belleville type, in regard to which we have a further discussion in another column of this issue. He says: "I can quite understand that in craft of very small dimensions and abnormally high speed, such as our new torpedo-boat destroyers, a type of boiler very much lighter than the cylindrical, or even the locomotive form, is an absolute necessity. I do not pretend to judge between the niceties of the Yarrow, Thornycroft, Normand, or similar designs, but I do say that none of them forms, in any way, a precedent for the use of the Belleville boiler in large ships. In these small fast boats rapid action is the order of the day; coal is burnt at a high rate of combustion per square foot of grate per hour; the water is circulated rapidly through the tubes, and the steam bubbles once formed are freed to do their work as early as possible. As far as I can learn, none of these quick movements are characteristic of the Belleville boiler, which appears to have its claims to notice based, not so much on speed, as on certainty of action; it is not so much the proper instrument for supplying steam for a high power in very limited room, as in the stokehold of a British warship, where it would have the best expert attention, as for supplying steam to turn the coffee-mill in a grocer's shop, and left to the tender mercies of the junior assistant. In fact, it was such considerations as these last that brought the water-tube boiler into active existence; the French authorities practically compel the use of safety boilers in towns; and so, having become the national boiler, it was inevitable that it would find its way on board ship." A long and careful review of the action of the Belleville boiler on board the ships of the Messageries Maritimes results in the conclusion that it is no more efficient for its heating surface or the space occupied than the cylindrical boiler, and that it is, therefore, a doubtful expedient to place it in vessels of large size where great power is demanded.

The conclusions reached by the author may be summed up in the statement, that the boiler capacities of the latest ships of the British Navy are ridiculously deficient in boiler power, and that the vessels will never be able to reproduce the results obtained on their trials over the measured mile; that the other navies of the world have recognized this deficiency in the English vessels and are devoting more space to the boiler installation, and that this is especially true of the United States, where the boiler capacity is made amply large for any service that the ships will be called upon to perform, a compliment to the designers of our vessels that must be gratifying to every one interested in the development of our new Navy.

* See AMERICAN ENGINEER AND RAILROAD JOURNAL for January, 1894.

BOILER FOR CLASS P LOCOMOTIVE, PENNSYLVANIA RAILROAD.

IN our issue for April we illustrated the piston and cylinder used on the Class P locomotives of the Pennsylvania Railroad. The engraving on page 310 illustrates the boiler that is in use upon these same engines. It is of the straight top Belpaire type, and is constructed entirely of steel. The Belpaire boiler has given considerable trouble by leaking at the connection between the barrel and the outer shell of the fire-box, or what corresponds to the wagon-top. This difficulty has been entirely overcome in the case of these boilers by flanging the connecting sheet in line, thus making the boiler straight top. The strains of expansion and contraction are in this way brought fair against the riveting, and all working due to buckling is avoided. The flanging for the boiler is done under an hydraulic press, as described in the May issue of this paper, where the dome base was given a special illustration. The cross-section through the fire-box shows the arrangement of stays and tubes. The latter are placed in vertical rows, spaced $2\frac{1}{2}$ in. from centre to centre; they are $1\frac{3}{4}$ in. outside diameter, 11 ft. $4\frac{3}{4}$ in. long over tube-sheets, and 258 in number. The stay-bolts for the side sheets average about $4\frac{1}{4}$ in. from centre to centre on the vertical rows, the spacing being such that this is the distance apart on the sheet curved to the longer radius. The spacing of the stay-bolts on the horizontal rows is $4\frac{1}{4}$ in. They are $\frac{7}{8}$ in. in diameter, and cut with 12 threads to the inch. The crown stays are $\frac{1}{2}$ in. in diameter, spaced $5\frac{5}{16}$ in. from centre to centre on the longitudinal rows and $5\frac{7}{16}$ in. on the cross rows. The mud ring is double-riveted. The old practice of using single riveting for the mud ring has disappeared from the best practice, and with it the disagreeable accompaniment of weeping fire-boxes. In some boilers built by Mr. McKenzie for the New York, Chicago & St. Louis Railway a few years ago, single-riveting was used, except at the corners where a double row was inserted. This overcame the trouble with leaking, we believe, but the practice has not, to our knowledge, been imitated elsewhere, and a double row is now the practice. The ring has a depth of $3\frac{1}{4}$ in.; the two rows of rivets are $1\frac{1}{4}$ in. apart, and the lower one stands up the same distance from the bottom.

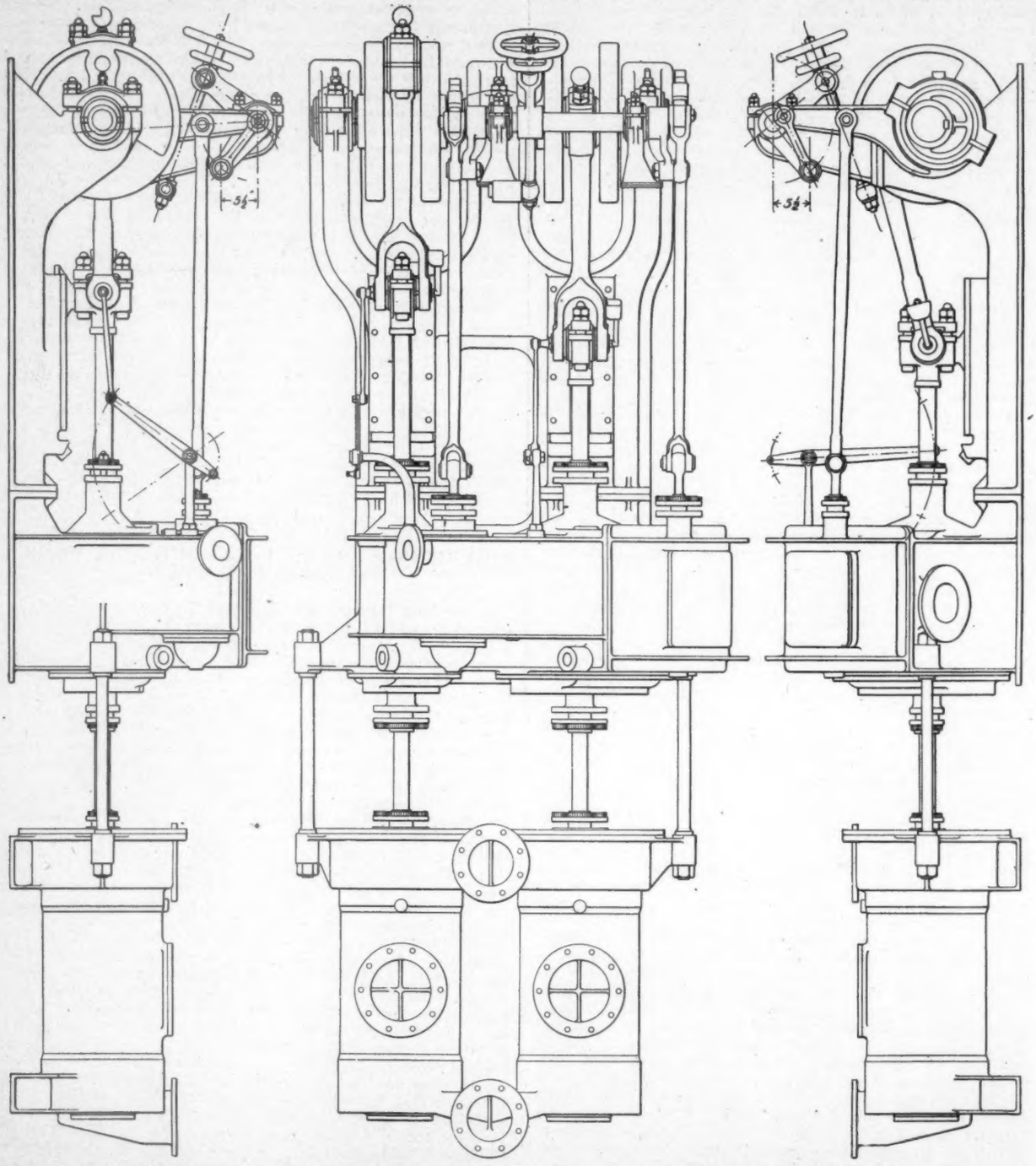
The barrel is composed of two courses of $\frac{7}{16}$-in. steel. Each course is made of a single sheet, with the longitudinal seams at 45° from the top for the forward and on the top for the back. These longitudinal seams are butted with an outside and inside welt. The outside welt, however, is but 4½ in. wide, and has two rows of rivets, one in each side of the sheet, while the inner welt is of sufficient width to take the four rows. The dome is riveted to the base, which is in turn riveted to the barrel, as described in our last issue. The dry pipe has an internal diameter of 6 in., and is carried in slings riveted to the shell, as shown in one of the cross sections.

The extension of the smoke-box is of $\frac{5}{16}$-in. steel, with a liner of the same thickness on the bottom.

The fire-box is formed of side and back sheets having a thickness of $\frac{5}{16}$-in., and tube and crown sheets $\frac{3}{8}$-in. thick, the front tube sheet is $\frac{1}{2}$ in. thick, and the back head $\frac{5}{16}$ in. The grates have an area of 31.18 sq. ft.; the heating surface of the fire-box, deducting the sectional area of the tubes, the fire-door, and the space below the grates, is 116.64 sq. ft.; the heating surface of the tubes measured on the outside is 1,435.2 sq. ft., or a total of 1,551.84 sq ft., making the ratio of grate to heating surface 1 to 49.77.

AIR-PUMPS FOR THE UNITED STATES BATTLESHIP "TEXAS."

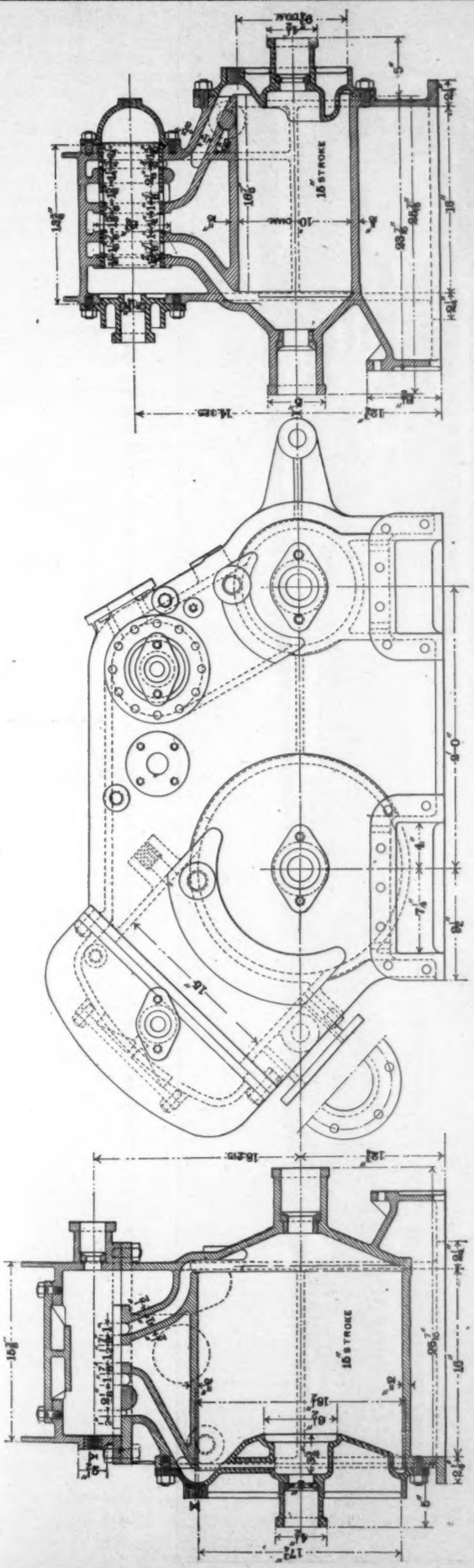
We have from time to time illustrated some of the details of the machinery on the United States battleship *Texas*, and through the courtesy of the Richmond Locomotive Works,



AIR-PUMPS FOR THE PROPELLING ENGINES OF THE UNITED STATES BATTLESHIP "TEXAS."

who were the contractors, we are now able to present illustrations and a description of the air-pumps used in connection with the main engines.

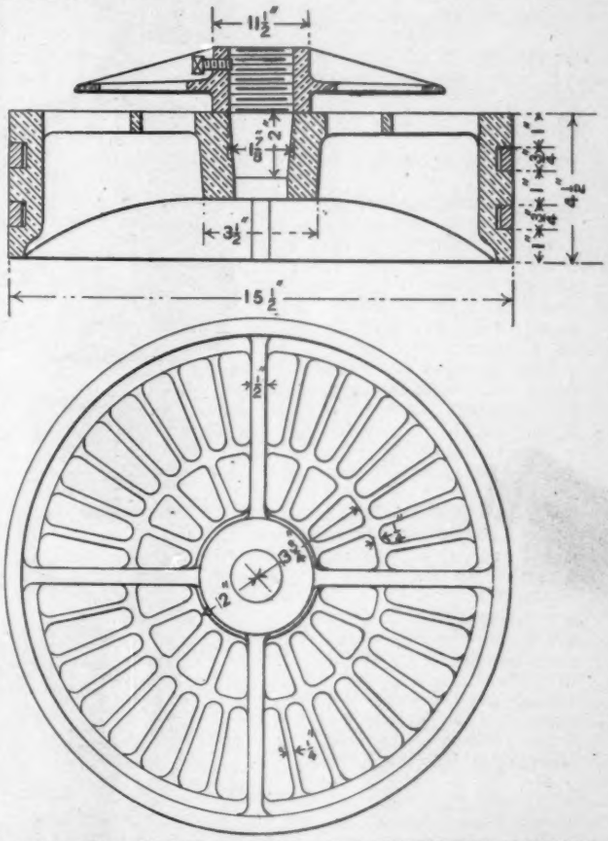
There are two single-acting, vertical air-pumps for each propelling engine; and they are worked by a two-cylinder,



STEAM-CYLINDERS FOR AIR-PUMPS OF THE PROPELLING ENGINES OF THE UNITED STATES BATTLESHIP "TEXAS."

vertical compound engine, which is placed above the pumps, the cylinders and pump barrels having a common centre line. The piston and pump-rods are made in one piece, and of manganese bronze. The engine and pump-cylinders are tied together by forged steel stays, as shown in the engraving, and the whole is bolted to the bulkheads by means of the flanges provided for the purpose and which are faced. The crank-shaft is above the engine cylinders with counterbalanced cranks standing at right angles to each other. This shaft is carried in three bearings, the central one being 10 in. long, and those at the ends 6 in. long each; the shaft itself having a diameter of 4 in. Each crank-pin is 4½ in. in diameter and 5 in. long, with a 2-in. axial hole drilled through it.

The engine cylinders are 10 in. and 18 in. in diameter, with a common stroke of piston of 15 in., and are bolted together, as shown on the engraving. The high-pressure cylinder is operated with a piston-valve, and the low-pressure with slide-valve, both being worked with the Marshall valve-gear. The cylinders, steam-chests, and engine frames are made of cast iron; steel castings are used for the pistons and cylinder covers; forged steel for the crank-shafts and connecting-rods, and cast steel for the crank webs and crank-pins. Each of the pistons is packed with three cast-steel rings sprung into place.

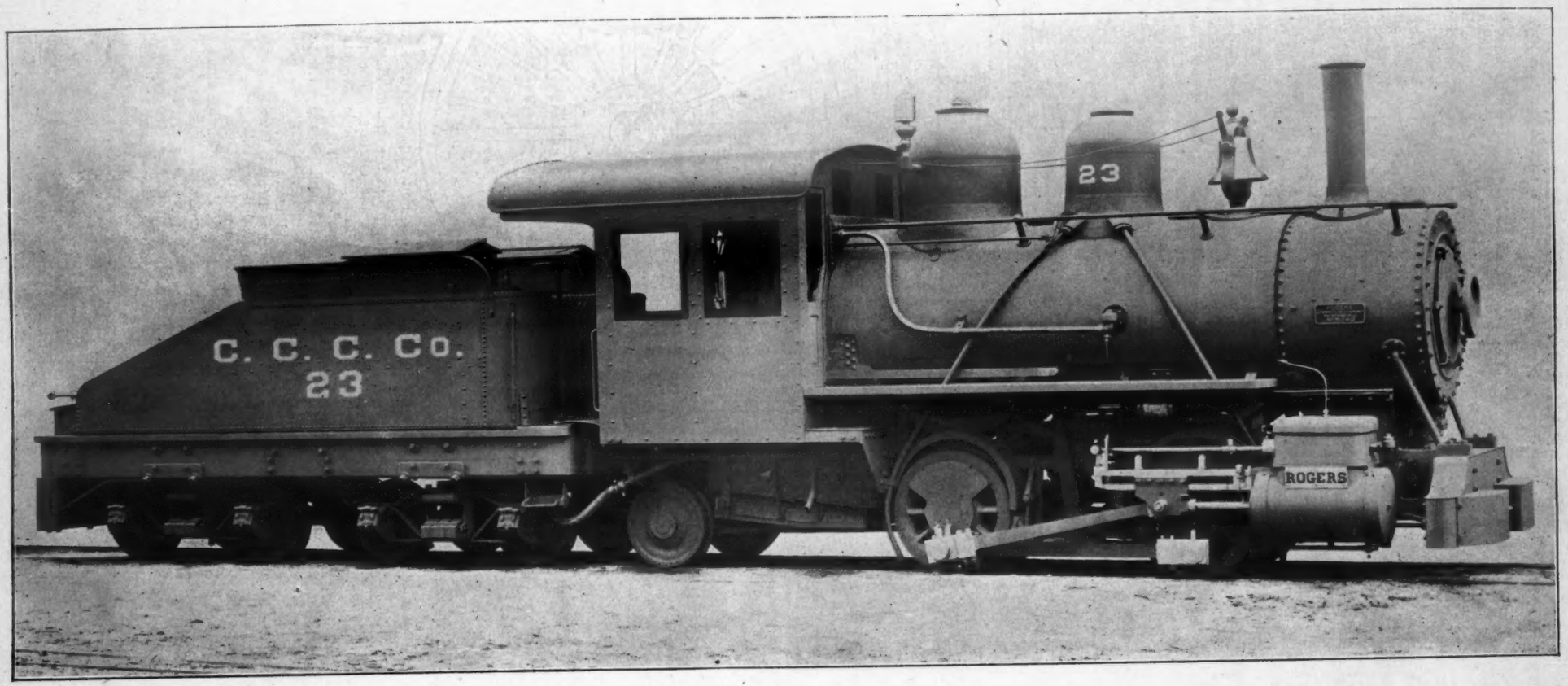


PUMP PLUNGER FOR AIR-PUMPS U. S. BATTLESHIP "TEXAS."

Each air-pump has a cylinder diameter of 15½ in. with the same stroke as the engines. The pistons are thoroughly ribbed, so as to secure ample strength for the work which they have to perform. They are turned to an accurate fit for the pump barrel, and packed with two brass rings sprung into place; there is also a grating in the pistons and guards, as shown by the engraving.

Each pump is provided with one foot-valve, one piston-valve, and one delivery valve; the seats and guards for each being provided with gratings, as given for the piston. Each valve consists of three disks of sheet brass $\frac{1}{32}$ in. thick, and of suitable diameters for the work. While these valves are held firmly in place, they are easily removed, the seats also being made separate from the pump casings and bolted in place. It will also be noticed that the design of the pump is such that there are no pockets in the pump chambers beneath the piston-valves where vapor can lodge.

All bolts and studs in the water space of the pumps is made of delta metal, and, for purposes of inspection, there is a round hand-hole, 9 in. in diameter, fitted with a cover, in the front of each pump barrel.



SWITCHING LOCOMOTIVE FOR THE CROSS CREEK COAL COMPANY, BUILT BY THE ROGERS LOCOMOTIVE COMPANY.

The air-pumps discharge into a feed tank placed in the forward part of each engine-room, and each one, together with its condenser, is expected to maintain a vacuum within 4 in. of the mercury of the atmospheric barometer, when the propelling engines are working at full power under a forced draft.

Like the other machinery that has been especially designed for this vessel, space has been of the first importance, and with this end in view the pumps illustrated have been designed. Bolted to the bulkhead they have no floor attachments, and occupy a horizontal area of 5 ft. 1 in. × 3 ft. 1 in. As already noted, the valves are driven by the Marshall gear, and are arranged in accordance with the following details:

	Top.	Bottom.
Lead	$\frac{3}{32}$ in.	$\frac{3}{32}$ in.
Lap	$\frac{7}{16}$ in.	$\frac{7}{16}$ in.
Cut-off	75 per cent.	75 per cent.
Compression	88 "	95 "

SWITCHING LOCOMOTIVE FOR THE CROSS CREEK COAL COMPANY.

THE Rogers Locomotive Company, of Paterson, N. J., has recently built a switching locomotive for the Cross Creek Coal Company of a striking design. It is of the Forney type, except that the trailing truck has but two wheels, and these are not used to carry the coal and water supply. The cab, as will be seen, is entirely metallic, and is carried on a foot-plate built out beyond the front end and carried by a brace bolted to the frame just back of the rear driving-wheel. The driving-wheel brakes are operated by a cylinder bolted to the under side of the running board acting upon a vertical lever coming down outside the frames. The following is a list of the principal dimensions of this locomotive:

DESCRIPTION.

Gauge	4 ft. ¼ in.
Fuel	Anthracite coal.
Weight on drivers	56,000 lbs.
" " truck-wheels	8,000 lbs.
" total	64,000 lbs.
Wheel base, total engine	13 ft. 8 in.
" " driving	6 ft.
Height, centre of boiler above rails	6 ft
" of stack above rails	11 ft. 8 in.

WHEELS AND JOURNALS.

Drivers, number	4
" diameter	36 in.
Truck-wheels, kind	Chilled cast-iron.
" diameter	26 in.
Journals, driving axle, size	7½ in. × 9 in.
" truck axle, size	5 in. × 12 in.
Axles, driving material	Hammered iron.
" truck "	Hammered iron.

CYLINDERS.

Cylinders, diameter	14 in.
Piston stroke	20 in.
" rod, diameter	2½ in.
Kind of piston-rod packing	Jerome metallic.
Steam ports, length	12½ in.
" " width	1¾ in.
Exhaust ports, length	12½ in.
" " width	3½ in.
Bridge, width	1¼ in.
Exhaust pipe	Single.

VALVES.

Valves, kind of	Richardson's balanced.
" greatest travel	4½ in.
" outside lap	1⅛ in.
" inside lap or clearance	Line and line.
" lead in full gear	$\frac{1}{16}$ in.

BOILER.

Boiler, type of	Straight top.
" working steam pressure	175 lbs.
" material in barrel	Central I. & S. Co.'s Steel.
" thickness of material in barrel	$\frac{7}{16}$ in. and ½ in.
" diameter of barrel outside at first course	52 in.
Seams, kind of horizontal	Quadruple-riveted butt.
" " " circumferential	Double riveted lap.
Crown sheet stayed with	Crown bars.
Dome, diameter	28 in.

TUBES.

Tubes, number	159
" material	Iron.
" outside diameter	2 in.
" length over sheets	9 ft. 11 in.

FIRE-BOX.

Fire-box, length	4 ft.
" width	3 ft. 9½ in.
" depth, front	60 in.
" " back	54 in.
Firebox, material	Central I. & S. Co.'s Steel.
" thickness of sheets	Flue sheet, ½ in.; crown, ⅜ in.; sides and back, $\frac{5}{16}$ in.
" brick arch	None.
Grate, kind of	Stationary bars with drop p ate.

TENDER.

Tank capacity	1,600 galls.
Coal "	3 tons.
Frame, type of	White oak.
Trucks, " "	Diamond.
Wheels, kind	Chilled cast iron.
" diameter	26 in.
Axle, material	Hammered iron.
Journals, size	3¾ in. × 7 in.
Brake on drivers	American Steam.

EARLY PASSENGER TRAFFIC ON RAILWAYS.

IN a recent number of the *English Mechanic* (May 17) Mr. Clement E. Stretton, the indefatigable railroad historian, has given the following interesting account of early passenger traffic on English roads:

"Questions are frequently asked with reference to the first introduction of passenger trains, and as to the early dates at which persons were conveyed by means of locomotive engines running upon iron rails.

"The answers usually given do not agree, for the simple reason that the questions are so extremely vague.

"As I pointed out to the authorities of the Transportation Department of the Chicago Exhibition two years ago, the very first step necessary toward ascertaining the required particulars is to divide the question into three important periods—viz.:

"1. The conveyance of persons by locomotive power upon private lines.

"2. The conveyance of passengers by mixed trains—that is, in carriages attached to coal or goods trains.

"3. The conveyance of passengers by complete passenger trains.

"Under heading No. 1 there can be no question that the first persons ever conveyed by a locomotive upon rails travelled on February 24, 1804, behind Trevithick's locomotive on the Pennydarran cast-iron plate-way, or tram-road, to Morthyr Tydfil, a distance of 9 miles. In order to convey long bars of iron, and also timber, wagons were constructed in pairs coupled together by an iron drawbar, having a joint at either end; these wagons had no sides, but in the middle of each there was fixed a centre-pin, upon which worked a cross-beam or bolster, upon which the timber or bars of iron were placed.

"The trucks in this case were loaded with 10 tons of bar iron, and upon the iron 70 persons either stood or sat.

"There can be no doubt that these '70 persons' were specially invited to witness the trial, and cannot, therefore, be considered as railway passengers.

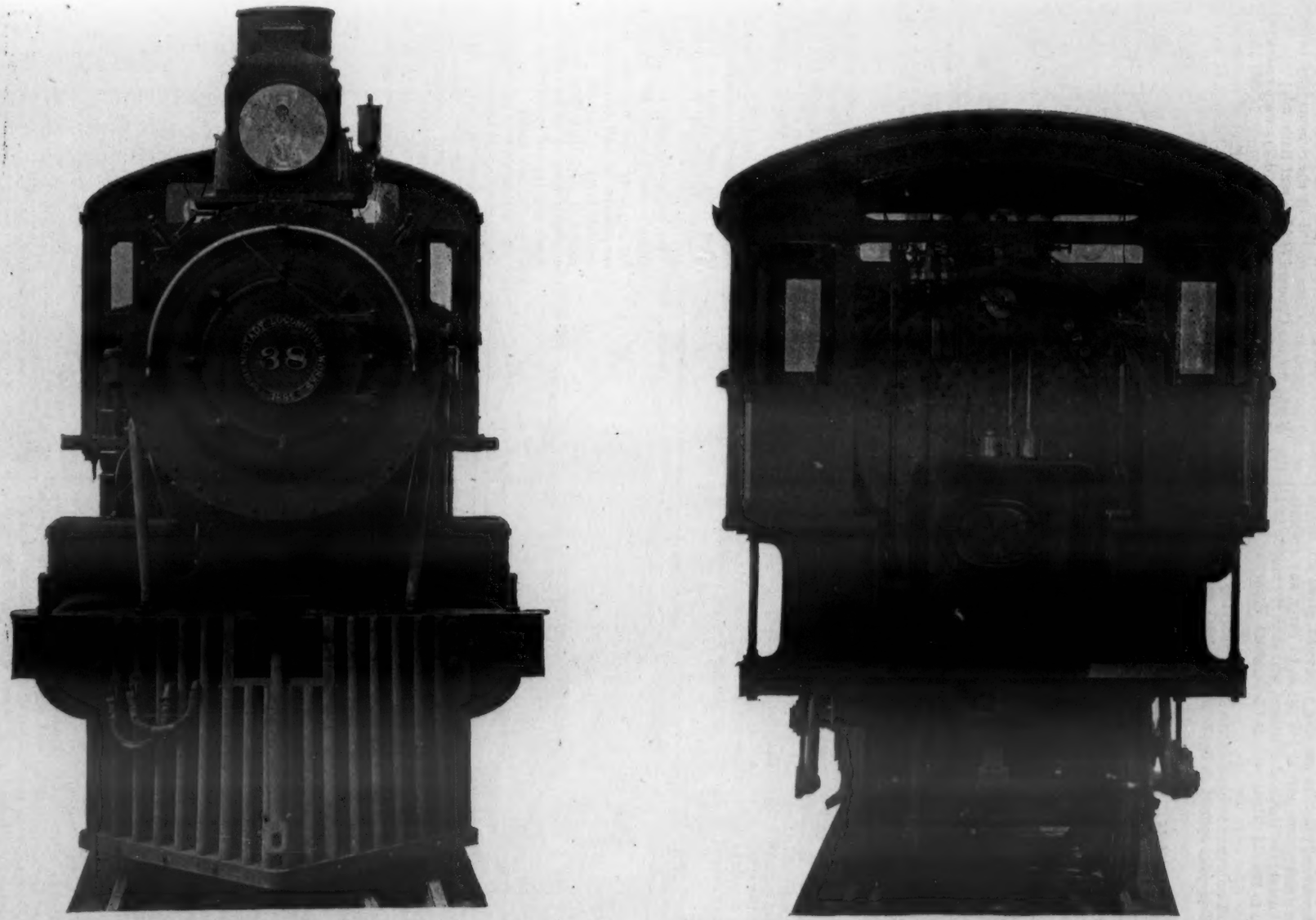
"In the year 1808 Trevithick had a circular experimental railway in London, near Euston Square and the site of the present London & Northwestern station, and upon this circle his engine, named *Catch-me-who-can*, ran round and round the circle at 12 or 15 miles an hour, and conveyed the general public at 1s. a head. This is certainly the first occasion upon which passengers paid to ride behind a locomotive; but it can only be regarded as an experimental run—not as a railway journey.

"In August, 1812, Mr. John Blenkinsop, the proprietor of the Middleton Colliery, Leeds, had an engine placed upon his railway, named the *Blenkinsop*, which had been constructed for him by Matthew Murray, of Leeds.

"Mr. Blenkinsop had a small covered vehicle constructed, in order that he and his managers could travel over the line. In order to convey the workmen from Leeds to Middleton Colliery, a distance of 3½ miles, the locomotive started every morning at 5.30 with a train of empty wagons, in which the workmen rode, and returned with a loaded coal train at 6 at night, the men then returning on the top of the coal. That arrangement of conveying workmen to and from work is believed to have existed from that day to the present time.

"George Stephenson's first locomotive, named the *Blucher*, was completed and tried for the first time upon the Kenilworth Colliery railway on July 25, 1814, and two days later it conveyed a train of wagons from one end of the line to the other. Lord Ravensworth and a party of his friends rode in the wagons, and having seen that the engine was a success, Lord Ravensworth ordered that the body of one of his four-in-hand coaches should be taken off its wheels and placed upon a wooden frame having flanged wheels. This early passenger coach was in use for over twenty years, and Lord Ravensworth and the officials of the colliery constantly used it when travelling over their line.

PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD, BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.



FRONT AND REAR VIEWS OF EXPRE~S PASSENGER LOCOMOTIVE, BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS FOR THE CONCORD & MONTREAL RAILROAD.

"The Duke of Portland, in 1817, followed almost exactly the course taken by Lord Ravensworth, for he had the body of one of his carriages placed on a frame in order that he could travel behind the locomotive upon his Kilmarnock & Troon tram-road; but its use was afterward given up, as the cast-iron tram-plates proved too weak to carry any engine, and ultimately the Duke of Portland sold both the engine and carriage to the old Gloucester & Cheltenham Tramway Company.

"With reference to heading No. 2, the Stockton & Darlington Railway was opened on September 27, 1825, and the trains were conveyed by the company's engine named *Locomotion*, and consisted of coal wagons and one passenger coach named *Experiment*. This vehicle ran upon four wheels, had a door at each end, and three windows at each side, a row of seats ran along each side of the interior, and a long deal table was fixed in the centre.

"For ten days this carriage was attached to coal trains, but the delays caused by shunting at sidings were so considerable that the stage-coaches on the road had no difficulty in beating the railway train, often by more than an hour. It naturally followed that the passenger traffic, which at first was small, was in a few days almost, if not completely, killed, and the company therefore decided to abandon 'mixed' trains, and to let the *Experiment* to a contractor, who worked it with his own horses and paid rent and toll to the company. This arrangement continued for several years, and passengers were not again conveyed by locomotives upon this line until after the Canterbury & Whitstable, Liverpool & Manchester, and Leicester & Swannington lines had been opened.

"On May 3, 1830, the Canterbury & Whitstable Railway was opened, and was worked by fixed engines over the inclines, and by the locomotive *Invicta* on the level portion.

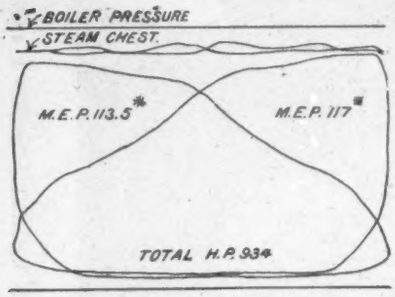
"'Mixed' trains were introduced: one, and sometimes two, passenger carriages being attached to the goods trains.

"So far it will be seen that no complete passenger train had been run; but on September 15, 1830, the Liverpool & Manchester Railway was officially opened by the directors and their friends, upon which occasion the company's eight engines and trains, and about 600 people started in a procession from Liverpool. On the following day, September 16, 1830, the Liverpool & Manchester Railway was opened for regular public passenger traffic, and several passenger trains ran daily between the two cities.

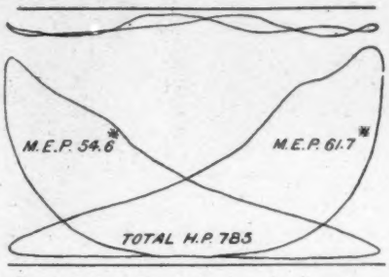
"In answer, therefore, to Question 3 it will be seen that the first complete passenger trains commenced work on September 16, 1830.

"CLEMENT E. STRETTON, C.E.

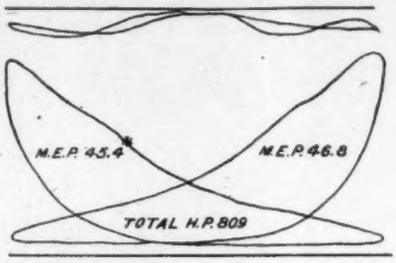
"SAXE-COBURG HOUSE, LEICESTER."



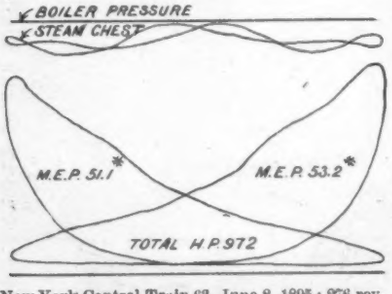
New York Central Train 64, June 8, 1895: 120 revolutions per minute; 25 miles per hour; 195 lbs. pressure; throttle wide open; cut-off, 12 in; vacuum, 4 in.; working, 90 ft. grade out of Albany.



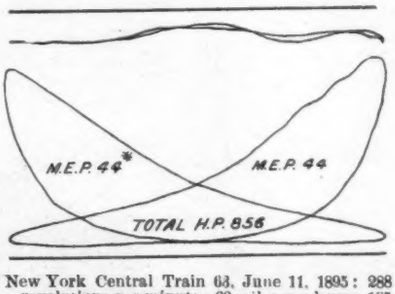
New York Central Train 63, June 8, 1895: 200 revolutions per minute; 41½ miles per hour; 190 lbs. pressure; throttle wide open; cut-off, $6\frac{7}{16}$ in.; vacuum, 3¾ in.



New York Central Train 63, June 8, 1895: 260 revolutions per minute; 54 miles per hour; 182 lbs. pressure; throttle wide open; cut-off, $6\frac{7}{16}$ in.; vacuum, 4¾ in.



New York Central Train 63, June 8, 1895: 276 revolutions per minute; 57 miles per hour; 186 lbs. pressure; throttle wide open; cut-off, $6\frac{7}{16}$ in.; vacuum, 4 in.



New York Central Train 63, June 11, 1895: 288 revolutions per minute; 60 miles per hour; 185 lbs. pressure; throttle, ½ open; cut-off, $6\frac{7}{16}$ in.

PASSENGER LOCOMOTIVE FOR THE CONCORD & MONTREAL RAILROAD.

THE accompanying photographs of side elevation, front, and rear view illustrate a heavy passenger locomotive recently designed and constructed by the Schenectady Locomotive Works for the Concord & Montreal Railroad.

In designing the locomotive the builders were restricted to a weight on driving-wheels not exceeding 76,000 lbs. In order to reduce to a minimum the evil effect of reciprocating parts on the track through the counter-balance of driving-wheels, the piston, cross-head, connecting-rods, crank-pins, and wheel-centres were reduced to the minimum weight, so that the effect on the rail at a speed of 60 miles per hour is only equivalent to the ordinary construction of American type of engine, with cast-iron driving-centres, weighing 9,000 lbs. less on drivers.

The driving-wheel centres are of cast steel and of very light weight, crank-pins are hollow, while the connecting rods, cross-heads, and piston are greatly reduced in section from ordinary practice.

Particular attention was paid to making the locomotive convenient for engineer and fireman; the arrangement in cab of reverse-lever, throttle lever, and all operating valves is such that they are as conveniently located as in the ordinary American type of locomotive having a deep fire-box boiler.

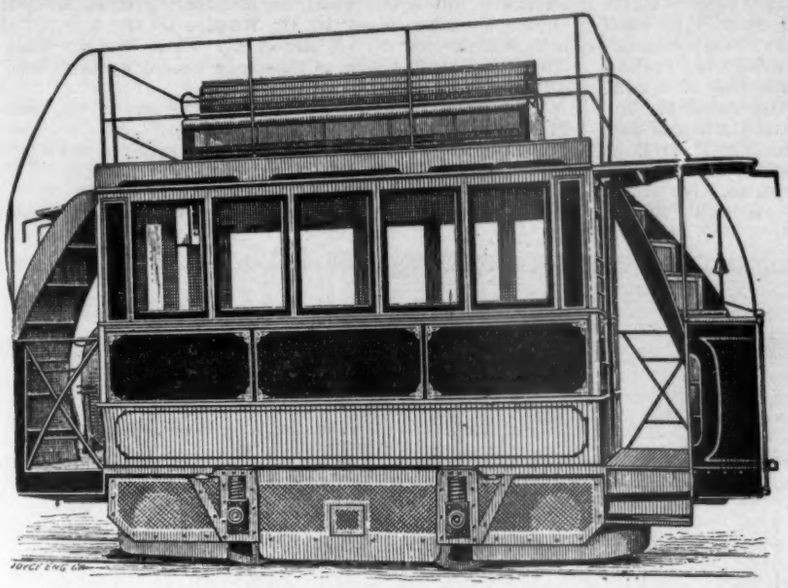
As will be seen by photograph and specifications, the boiler is of the extended wagon top radial stay type with wide fire-box, extending out over frames and over back driving-axle and sloping down toward front end, giving a depth of 25 in. below shell of boiler, thereby allowing ample space for fire between grates and fire-brick.

The general design of the engine is similar to the 16 engines recently built by the Schenectady Locomotive Works for the Boston & Albany Railroad.

The following are the principal dimensions and weight of the engine:

Cylinder diameter	19 in.
Piston stroke	24 in.
Driving-wheels, diameter outside of tires	70 in.
" " of centres	63 in.
Driving-wheel centres of cast steel, tires held by retaining rings.	
Boiler, extended wagon top, radial stayed.	
Working pressure	190 lbs.
Boiler diameter at front end	60 in.
" " back end (back head a true circle)	70 in.
Fire-box, inside length	90 in.
" width inside	40½ in.
" depth at back end	61½ in.
" " front end	73¼ in.
Tubes, number of	299
" diameter	2 in.
" length	11 ft. 6 in.
" space between	¾ in.
Weight of engine in working order	116,400 lbs.
" on drivers	75,000 lbs.
Total wheel base of engine	23 ft. 9 in.
Driving-wheel base of engine	8 ft. 6 in.
Driving-axle journals	8 × 11.
Engine truck journals	6 × 10.
Tender " "	4½ × 8 in.
Diameter of engine truck wheels	36 in.
" " tender " "	36 in.
Tank capacity	4,000 galls.

Tender frame is made of 6½ × 4 × ¾ angle iron.



THE GAS-MOTOR CAR IN DRESDEN.

The tender trucks are the Schenectady Locomotive Works standard iron truck, with channel iron floating bolsters and inside brakes.

Engine and tender truck-wheels are the Snow boltless steel-tired wheel.

Locomotive is fitted with the Westinghouse air-brake on driving-wheels, tender, and train; Westinghouse air signal, Richardson balance valves, Leech sand-feeding device, Nathan & Co. sight-feed cylinder oiler, Hancock inspirators, and Smith triple-expansion exhaust nozzles.

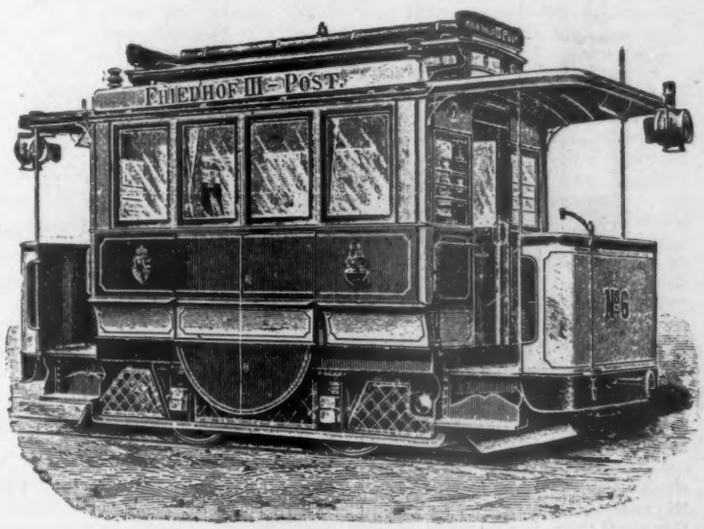
Previous to the delivery of the locomotive it was run a few trips on the New York Central Railroad on heavy fast passenger trains, and the accompanying indicator cards obtained.

THE GAS-MOTOR IN DRESDEN.

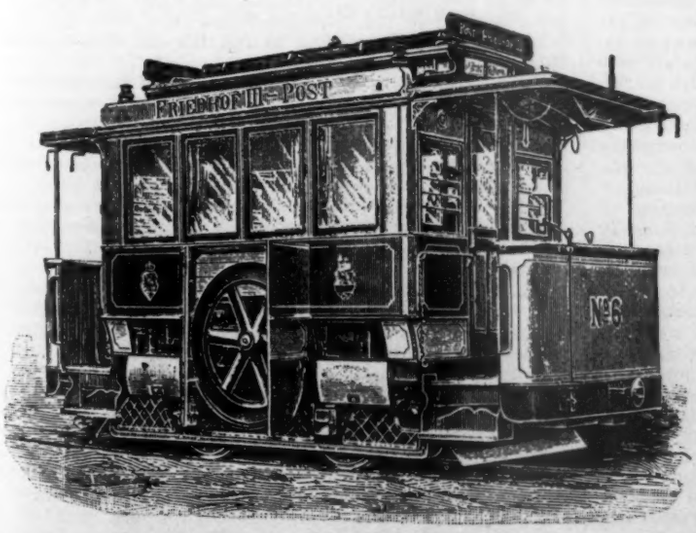
THE gas-engine has been the subject of repeated experiments, both in this country and abroad, with the end in view of adapting it to tramway service. The great successes that have been achieved in using it in competition with steam have added a new incentive to its applications as a street-car motor. The consular reports issued by the State Department have contained a number of descriptions of such applications;* the latest of which comes from our Consul-General at Dresden Mr. William S. Carroll, which we reprint in full.

"About one year ago I witnessed a trial trip of a gas-motor car in this city, and since that time I have watched the progress and improvements that have been made, and am now able, with the aid of information obtained from Mr. John Young, Superintendent of the Gas Traction Company (Limited), London and Dresden, to report that the motor during the first trial trip worked fairly well, but showed some deficiencies, apparently in its mechanical construction, and that since that time those deficiencies have been remedied, and during later trial trips the motor car has proved entirely satisfactory.

"At the first trial the car always started with a noticeable jerk and did not run smoothly, and when not in motion a considerable quantity of gas was used to keep the motor running, causing the car to sway and tremble; the clutch coupling did not work regularly and broke easily; the car was clumsy and unsightly. All these objections have apparently been overcome, and an easy, manageable, economical motor for public traffic is the result.



THE DRESDEN GAS-MOTOR CAR SHOWING FLY-WHEEL DOORS CLOSED.



THE DRESDEN GAS-MOTOR CAR SHOWING FLY-WHEEL DOORS OPEN.

"The illustrations will show the appearance of the car.

"This car weighs 5½ German tons (about 12,127 English pounds). The distance between the wheels is 1.55 metres (about 5 ft. 2 in.), and the length of the car frame is 3.5 metres (about 11 ft. 5 in.). There are 14 inside seats, 10 on both platforms, and 12 on the top of the car, making a total capacity of 36 seats.

"The car has a gauge of 1.435 metres (about 4 ft. 7 in.), and has the appearance of an ordinary street-car, excepting the two folding doors in the centre of one side of the car, which cover the driving-wheel *S*.

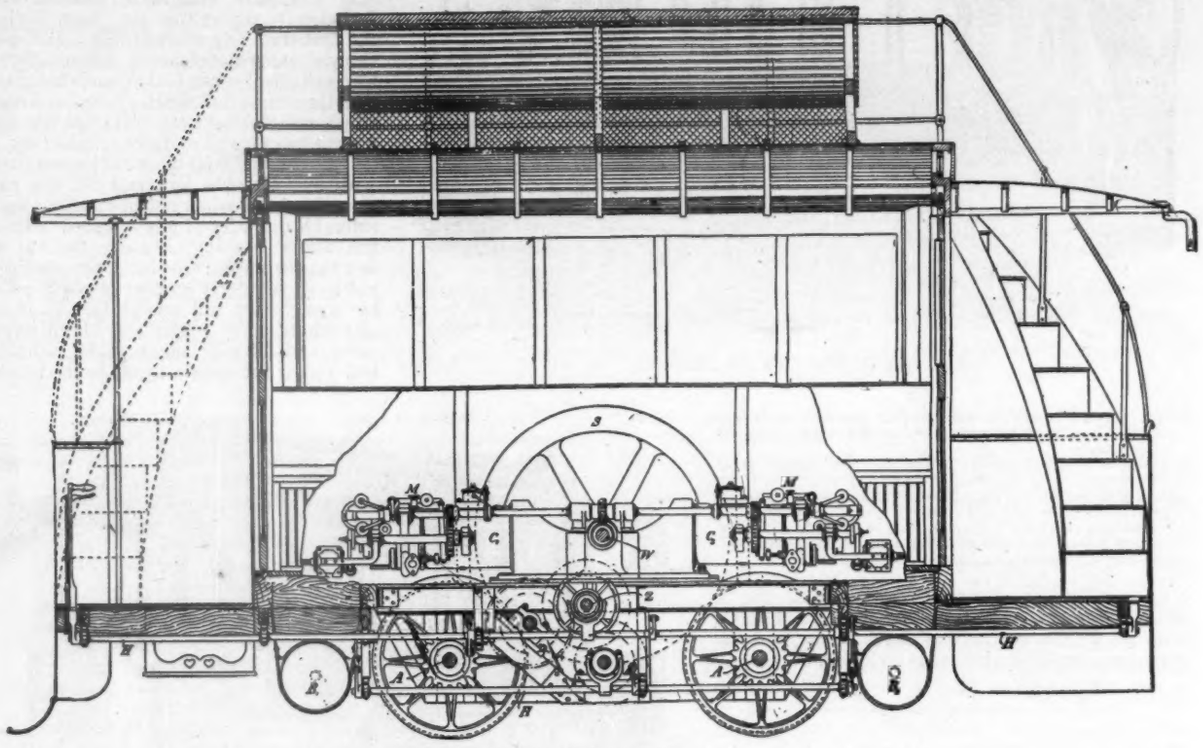
"The illustration will show the working of the motor.

"The motor has 10 H.P., with two cylinders (C^1 and C^2), which are placed in line under one of the rows of seats, one on each side of the shaft.

"The gas in the machine is ignited by electricity without any noise. Two cylindrical gas tanks (B^1 and B^2) are fixed parallel with the axles of the wheels under the floor of the car; a third gas tank is placed lengthways under the row of

* See AMERICAN ENGINEER AND RAILROAD JOURNAL for August, 1894, and October, 1894.

seats opposite the machinery, and serves as a proper balance to the car. These three gas tanks hold about 0.95 cubic metre (33.55 cub. ft.) of gas, and weigh about 250 kilogrammes (551 lbs). The water used in cooling the cylinders circulates automatically through copper tubes eight-tenths of a millimeter (0.0315 in.) thick, which run from the top to the bottom of the car in a spiral shape. The water, when heated, rises to the top of these tubes, where it cools and then flows back into the gas cylinders. The tubes are concealed under the seats. The gas tanks are covered by plates. No part of the machinery is visible inside of the car. It is only accessible from the outside by opening the two large doors above mentioned and a number of smaller doors. The car, while in motion, is noiseless, and there is no odor from the gas.



LONGITUDINAL SECTION OF THE DRESDEN GAS-MOTOR CAR.

"The driving-gear consists of four shafts. The motor-shaft *W* is driven directly by the gas motor, and transmits the motion by means of cogged wheels on the shaft *Z*. On this shaft there is a peculiar friction coupling, *R*, as shown in the cross-section view of the machinery.

"This friction coupling regulates the speed of the car by means of a reversing lever, *H*, connecting a larger or smaller spur-wheel, as may be desired, with the other parts of the machinery. Both wheel-axles are driven by chains and chain-wheels *K*, which run in oil, so as to use the entire adhesive weight of the car for the development of the tractive power. To diminish the friction, the bolts at the joints of these chains are incased in steel, which can revolve, and thus prevent any noise while the machine is working. During short stops the machine remains in motion. By means of a lever the machinery is thrown out of gear to stop the car; while out of gear the motor uses very little gas, because the number of revolutions is diminished, and only after every 8 or 10 rotations a new ignition of the gas occurs, which is sufficient to keep the motor in motion. One of these levers is connected with the 'friction coupling,' and serves to diminish or increase the speed of the car from 150 to 240 rotations per minute; the other lever is directly connected with the motor and controls the movement of the car forward or backward. The levers are easily controlled by the conductor.

"An alarm bell, similar to those used on ordinary horse-cars, is attached to the handle of the brake. The levers and brake-handles are easily removed from one platform to the other, as may be required when changing the direction of the car.

"The wheels of the car are peculiarly fastened to their axles. One wheel is secured to the axle, while the other can slip in its hub in the proportion of 80 per cent. of the circumference of the axle toward the neighboring wheel until it is necessarily taken along by the rotation of the axle. Thus, both wheels can revolve differently when the car takes a curve, and the friction or resistance caused by the curve is greatly diminished.

"The speed obtained at the trial trip was at the rate of 14 kilometres, or about 8.7 miles per hour. All curves were overcome with ease, and without any swaying or jerking motion, the smallest radius being 15 metres (49.2 ft.). The speed was diminished while passing over the curves.

"The consumption of gas amounted to about one-third of 1 cub metre (11.74 cub. ft.) per kilometre (0 621376 mile),* 1 cub. metre (35.316 cub. ft.) of gas costing 12 pfennigs (2.86 cents). The average cost of gas per kilometre, or 3,280 ft. 10 in., would be 0 04 pfennigs (0.95 cent).

"The gas used for the motor is under a pressure of 6 atmospheres, and the manometre shows at all times the amount of gas consumed.

"The compressed gas enters at first into a regulator for gas pressure (Pintsch system), where the pressure is reduced from 30 to 40 millimetres (1.18 to 1.57 in.) water pressure. The gas contained in the three gas tanks—viz., 0 95 cub. metre (33 35 cub. ft.) is sufficient to run the car 17.1 kilometres (10.63 miles).*

"The gas-supply station consists of an 8 H.P. gas motor, which runs a force pump with a capacity to compress about 60 cub. metres (2,118 cub. ft.) of gas to 8 to 10 atmospheres per hour. The gas is taken from the city gas-pipes in the street, and the tanks in the cars are filled by using rubber tubes or hose; they can be filled in about thirty seconds.

"The cooling water must be removed from time to time, but not so often as the gas. This is done by means of water taps at the filling station. In extreme cold weather a little glycerine is used to prevent the water from freezing.

"It is estimated that a car like the one described can be built and fully equipped for about 15,000 marks ($3,570). This estimate is based upon the price of labor and materials in Germany and on the theory of manufacturing on a large scale.

"It is impossible now to fairly estimate the average life of a car or the annual expenses for repairs.

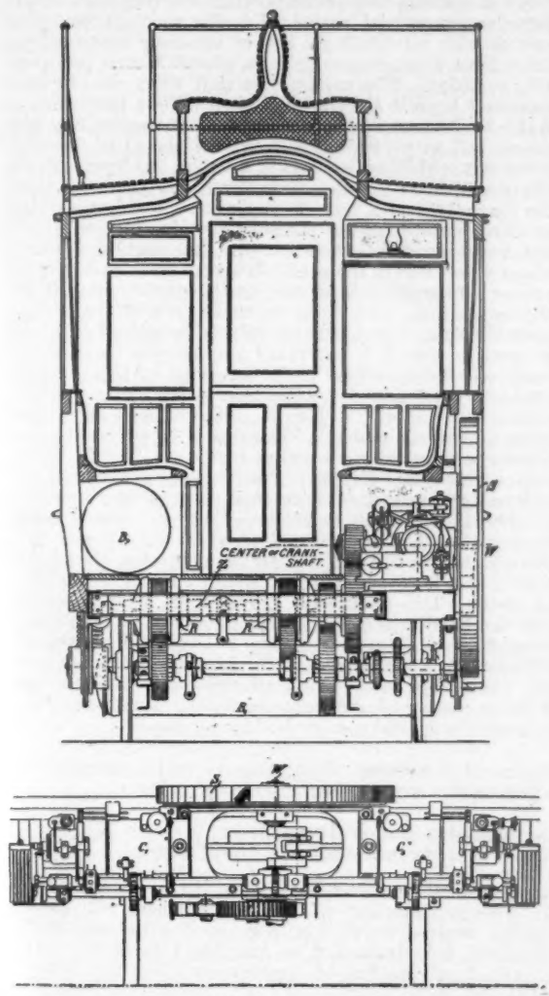
"This system of motor power is attracting wide attention, and many German cities are adopting it for street cars. Trials are proposed to be made with gas locomotives for narrow-gauge railroads and for shunting purposes at railroad stations."

* There is a wide difference between these estimates.

THE INTERNATIONAL RAILWAY CONGRESS.

A RECENT number of *The Engineer* contains the following outline of the proceedings of the Congress, which began its session on June 26:

The fifth session of the International Railway Congress will be held this year in London. The meetings will take place in the Imperial Institute buildings, which will thus for once be used to some purpose. The Railway Congress was established a little more than four years ago. Its object is the acquisition and diffusion of information on all matters connected, even somewhat remotely, with railways. The number of members is not stated; and, indeed, it may be taken for granted that all railway men are, in an *ex-officio* sense, members. Those who attend the meetings of the Congress are known as "delegates," and the magnitude and importance of the forthcoming meeting may be realized when we say that 800 delegates are expected to attend. Of these, 600 will come from the United States, South America, Canada, Australia, New Zealand, France, Germany, Belgium, Russia, and Italy, to say nothing of less considerable countries. The remaining 200 represent the railways of the United Kingdom. The business of the Congress is transacted on somewhat exceptional lines. Papers or reports, or answers to questions, are printed and circulated among the members during the year, the Congress having an official organ of its own, the *Congress Bulletin*, in which various languages are used as occasion demands. The separate reports are reprinted from the *Bulletin* and circulated. One lying before us may be taken as a specimen It refers to a question—No. XV.—concerning the twenty-four hours' day, which question is thus summarized: "Introduction in time tables of continuous reckoning from one to twenty-four hours, and of the division of the hour into 100 parts; present state of the question; practical adoption in different countries; advantages to the public and to the railway service; would the alteration of existing clocks be necessary, and if so, how could it best be accomplished?" The report is by MM. Scolari and Rocca. They discuss the whole question elaborately, and arrive at a conclusion in favor of the twenty-four hours' system, which is not remarkable seeing that they are Italians, and that the system has been in force in Italy for centuries. None of the papers or reports will be read at the forthcoming meeting, not even the summaries prepared in most cases by the authors. On the first day only official business will be transacted. The meeting will be broken up into sections, each with its chairman or president, and on subsequent days the reports and papers will be discussed by the various sections; but the conclusions and recommendations at which they arrive, and which they frame, must be submitted to the whole body of delegates before they can be regarded as satisfactory or sanctioned by the Congress. Thus it will be seen that in certain respects the arrangements are very similar to those of the British Association meetings. It is impossible at present to say which reports will be brought forward for discussion, but the number is considerable, and the proceedings are certain to be of interest. Each day a little journal will be published and circulated among the delegates, supplying them with information which could in no other way or with so little loss of time be imparted.



CROSS-SECTIONS OF THE DRESDEN GAS-MOTOR CAR.

The whole time of the delegates will not be spent in discussing papers and reports. Visits will be paid to places of interest, and excursions will be made to various parts of the kingdom. The accompanying programme, which has been brought down to date, will convey to our readers the most recent information. The offices of the Congress are at 29, Abingdon Street, Westminster. Mr. Acworth is the Secretary. We believe that no qualifications will be required by those wishing to attend the meeting, save the fact that they are in some way connected with railways and their working, and so have a real interest in the proceedings.

The Congress will be opened ceremoniously by the Prince of Wales, on Wednesday, June 26, at 3 P.M., and at 10.30 P.M. there will be a reception by Mr. Bryce, the President of the Board of Trade. The remainder of the week will be devoted to excursions into Lancashire and elsewhere. On Monday, July 1, the serious business of the meeting will begin. On Tuesday evening there will be a grand banquet given at the Imperial Institute by the Railway Companies Association. On Wednesday morning there will be sectional as well as general meetings, and in the afternoon excursions to points of railway interest in or near London. Thursday and Friday will be devoted to business, and on Saturday there will be a pleasure excursion to Brighton, so that foreign delegates may escape from London on Sunday. On Monday, July 8, more business, and in the evening a banquet at the Crystal Palace. On Tuesday the Congress will be wound up, the closing ceremony will take place, and large numbers of the delegates will start for Scotland to see the Forth Bridge, to Ireland, and other parts of the United Kingdom. It will be readily understood that the delegates will not be idle, to say nothing of the Secretary and other officers, whose duties will be singularly arduous.

The great railway companies have prepared a special programme of excursions for June 27, 28, and 29.

The following is an abstract of the official list of subjects for the meeting of 1895:

SECTION 1. PERMANENT WAY AND WORKS.

1. *Strengthening Track in View of the Increased Speed of Trains.*—Type of track, section of rail and quality of steel, including comparison of soft and hard steel. Rail joints, ties and ballast.

2. *Special Places in Track.*—Means to avoid the necessity of express trains slackening speed, and to prevent shocks in passing sharp curves, long and heavy grades, split switches, track and road crossings at grade, drawbridges, etc.

3. *Junctions.*—Best arrangement on main lines to avoid having to slacken speed, and the best means of maintaining speed with safety while abandoning superelevation on the junction curves.

4. *Construction and Tests of Metal Bridges.*—Specifications and requirements for grade of metal. Methods of original and periodical testing of bridges, and can such methods be regarded as of practical value in settling the actual state of repair and margin of safety?

SECTION 2. LOCOMOTIVE AND ROLLING STOCK.

5. *Boilers, Fire boxes and Tubes.*—Steel boilers and fire-boxes. Purification of feed-water. Experiments as to the production

of steam—viz., results obtained with tubes of different dimensions, material, and spacing; influence of smoke-box capacity and form of smoke-stack, spark arrester and exhaust pipe, and the influence of speed on the production of steam.

6. *Express Locomotives.*—The type of engine and the use of high pressure and compound system. Steam distribution and balanced slide-valves. Locomotive construction (simple and compound) from the point of view of diminishing the strains on the track.

7. *Rolling Stock of Express Trains.*—Cars for express trains and long journeys. Vestibuled trains. Improvements in interior arrangements, and in car heating and lighting.

8. *Electric Traction.*

SECTION 3. TRAFFIC.

9. *Acceleration of Freight Traffic.*—Influence of speed upon the expenses of hauling, the utilization of cars, the number of cars, and the accommodation and plant required.

10. *Station Working.*—Methods of accelerating the switching of cars and handling of freight. Sorting yards. The employment of mechanical and electrical appliances in switching and in making up trains.

11. *Signals.*—Improvements and economy in block and interlocking plants. Signals in tunnels. Form instead of color signals to avoid dangers from color blindness or defective sight. Methods of preventing collisions at dangerous points on express lines in case of trains passing signals at danger.

12. *Cartage and Delivery.*—The collection and delivery of freight.

SECTION 4. GENERAL.

13. *Organization.*—Central administration and executive and outdoor staff.

14. *Settlement of Disputes.*—This refers to disputes between railways as to freight traffic.

15. *Twenty-four-Hour Notation.*—Introduction of time tables reckoning time from one to twenty-four hours. Division of the hour into 100 parts. Alteration of clocks. Present status of the question.

16. *Decimal System.*—The general adaptation of the decimal system in calculations and accounts, and the general introduction of the metric system.

SECTION 5. LIGHT RAILWAYS.

17. *Contributive Traffic.*—A method for main railways to encourage the building of working of light feeder lines. In the case of light railways what relaxations can be made by the government in its standard requirements of construction or working without risking the public safety.

18. *Leasing Light Railways.*—The system of working light railways by leasing companies, and the terms of leases, with the practical results.

19. *Light Railway Shops.*—Should the principal shops be at the middle or one end of the line?

20. *Brakes for Light Railways.*

Several delegations of railroad men from this country have sailed for Europe during the past month to attend the congress which was opened on June 26, and which promises to be a very interesting and profitable meeting. The three days following the opening ceremonies will be devoted to the inspection of English railways, and a very enticing programme is offered to those who will be there.

An exhibition of English railway appliances is now and will remain open during the session of the congress. This exhibition is described in *The Engineer* of June 7 as follows:

"The exhibition of railway appliances was opened on the 1st instant. It is a very small affair, contained in a corrugated iron shed in one of the yards of the Imperial Institute, with an overflow of certain exhibits into otherwise unused whitewashed passages below the level of the street. Why an exhibition of the kind should have been held at all in Kensington would have been an inscrutable mystery did we not know that the Railway Congress is to meet in the Imperial Institute, and no doubt it has been concluded that many of, if not all, the 600 delegates will find their way into the exhibition. There are in all 90 stands, none of which bear a number as yet; and a great many of these stands are occupied by models, for the most part by more or less amateur inventors of electric railway signals, detonator setters and such like. The most important exhibits are no doubt those of such firms as Saxby & Farmer, Siemens Brothers, Dalton & Co., the Gloucester Carriage & Wagon Company, and others well known in the railway world. There are some things shown which excite mild surprise; for example, we have the old automatic brake, a development of an idea born in the days when the *Rocket* yet ran. The weight of the wagon applies a brake, and the pull of the engine takes it off. The fundamental theory of such a brake is all wrong, because the engine could not run with steam off, and the brake would go on, whether it was wanted or not, on an incline. Then there are automatic couplers exhibited. These appear to be superfluities, seeing that there is reason to believe that there are now running in the United States 7,000 distinct patents for couplers, and that the number is being augmented at the rate of about four per week, with occasional spurts of eight or ten.

"In a succeeding impression we shall describe those exhibits which deserve special notice. For the moment we content ourselves with mentioning a few of the more noteworthy exhibits. First among these may be placed West's patent tire-setting machine. The principle is that when steel or iron is compressed beyond the elastic limit it takes a permanent set. The tire to be secured is submitted to a tremendous radial pressure, and as a result it is shortened and grips the wheel. The machine exhibited consists of a strong weldless steel ring, inside of which are disposed 18 hydraulic presses with rams 8 in. in diameter, and a very short stroke. The heads of these rams carry curved pieces precisely like brake blocks. The wheel to be hooped—when we saw the machine a hickory carriage wheel was in the press—is a very slack fit in the tire; the press is brought to bear, and as the pressure is half a ton to the square inch, each press exerts 25 tons, or the whole 18 presses 450 tons. This has to be endured by a tire 2 in. × ¼ in. The result is that it is shortened permanently by as much as an inch, and fits the wheel perfectly. One of these machines has been at work now for some time in the gun-carriage department at Woolwich. This is a very curious and original process well worth seeing. The press is in action at the exhibition every day at noon and at four P.M. Messrs. Siemens Brothers have a nice display of electrical apparatus, and a railway wheel and axle fitted with Meneely's tubular roller bearing. The Patent Shaft & Axletree Company shows nothing very novel, but the stand will well repay a visit. Messrs. Saxby & Farmer have a full-size signalling apparatus, showing the union of the lock and block systems, a notice of which we must defer. The Gloucester Carriage & Wagon Company shows two handsome railway carriages, one for light railways, to carry 30 passengers, which seem to be specially designed.

"There are a multitude of carriage locks, improved windows, ventilators, mats, carriage upholstery fittings, lamps and other matter of the same character. But none of these things call for special remark at this moment."

Copies of a number of the reports to be presented have reached us, and among them are the following:

STRENGTHENING OF PERMANENT WAY IN VIEW OF INCREASED SPEED OF TRAINS.

By William Hunt, Chief Engineer of the Lancashire & Yorkshire Railway, Manchester. The report consists of a summary of replies received from 13 railways in England and Wales, 4 in Scotland, 2 in Ireland, 6 in America, 1 in India, and 1 in Australia to a circular of inquiry covering the following points:

Type of permanent way suited for lines traversed by trains at high speed. Gradual strengthening of existing roads, so as to permit of an increase in the speed of trains.

A. Section of rail. Calculation of the strains trains imposed by the rolling load. Results of experiments.

B. Mode of manufacture and nature of rail metal. Comparison of soft with hard steel. Steel produced (1) by the acid process in the Bessemer converter; (2) by the basic process in the converter; (3) by either process in the Martin furnace.

C. Rail connections. Fatigue of fish plates. Construction of joint best calculated to secure uniform strength of the road throughout. Rails laid in chairs, and Vignole's rails.

D. Sleepers: their quality, dimensions and distance apart.

E. Ballast: the various descriptions and methods of laying.

There is nothing especially new or interesting in the report. We are told what is generally known—that in the United Kingdom bull-headed steel rails are almost universally used, and in this country flat-bottomed rails. In England the weight of rails varies from 80 to 82 lbs. per yard; in Scotland, from 77 to 90 lbs.; in Ireland, from 74 to 85 lbs. The length of rails adopted by English companies is generally 30 ft. The Great Western Company's rails are 32 ft. long, and the London & Northwestern are adopting a length of 60 ft. Most of the companies subject the rails to a test by a falling weight. Some test the rails as girders, suspending dead weights from

the centre and specifying the deflection. Chemical tests are not generally used. The breaking weight in tons per square inch is specified by five companies. Elaborate tables containing the details of the replies to the circular of inquiry and 35 pages of illustration accompany the report.

PLACES IN PERMANENT WAY REQUIRING SPECIAL ATTENTION.

By M. Sabouret, Ingénieur des Ponts et Chaussées, Principal Permanent Way Engineer of the Paris-Orleans Railway Company. This report, of 19 pages, relates to "means to avoid the necessity of expresses slacking speed and to prevent shocks in passing special points, such as sharp curves, long and steep gradients, facing points, rail crossings, road crossings, swing bridges, etc."

BOILERS, FIRE-BOXES AND TUBES.

By Ed. Sauvage, Chief Engineer of Mines, Assistant Locomotive Superintendent of the Eastern Railway of France.

M. Sauvage's report, of 74 pages, resembles similar reports made to our Master Mechanics' Association. It relates to the following points:

A. Steel boilers and fire-boxes. Strain to which they are subjected in use and conditions on which the plates are accepted.

B. Iron tubes. Means of preventing leakage in the tube-plates.

C. Injurious effects of the feed-water on the boilers and tubes. System of purifying.

D. Synopsis of experiments as to the production of steam.

The latter relate to the experiments carried out by the Paris-Lyons-Mediterranean Company, under the direction of the late Mr A. Henry, a report of which has been published in the AMERICAN ENGINEER. M. Sauvage's report gives a large number of illustrations of boilers used on various roads in Europe and this country, and shows some of the details of their construction. He also gives illustrations and descriptions of different methods of fastening tubes and of various forms of spark arresters and blast pipes. The following are his conclusions:

"1. The use of mild steel for the boiler plates of locomotives has become a matter of current practice; this use being mainly justified by the quality of the plates, which is much more uniform than in iron. Particularly in the flanged portions of the work steel is more readily worked.

"2. Steel plates for boilers should be very mild, and characterized by a breaking strain not exceeding 28½ tons per square inch, and preferably between 25½ and 22 tons per square inch. The plates will be made from open-hearth steel, and no pig containing phosphorus should be used in their manufacture.

"3. The substitution of steel for iron allows at times of a slight increase of pressure in the boilers without any modification in thickness of plate.

"4. The working up of steel plates does not require any extraordinary precautions; they can stand local application of heat, notably for the drawing out of the corners. A wise precaution is to anneal the plates after working them prior to riveting; nevertheless, this precaution is not indispensable when experience has proved the good quality of the plates and the merit of the boiler-maker's work.

"5. Steel fire boxes continue to be practically unused in Europe; the few cases in which they have been experimented with do not show that they have any advantage over the copper box, at least with the qualities of steel available in Europe. This opinion does not apply to small locomotives whose work is not of a very hard nature; for these, steel fire-boxes may be advantageously used.

"6. Iron and steel boiler tubes have come more and more into use; they can be substituted for brass without disadvantage, the substitution actually resulting in a considerable economy.

"7. Iron tubes do not require copper ends.

"8. The tubes are generally expanded with a dudgeon expander, the holes in the tube plates being slightly coned or even cylindrical.

"9. The beading of the ends of the tubes is not indispensable.

"10. Ferrules are only necessary at the fire-box, and then only when the tubes show signs of leakage.

"11. In general it may be said that the avoidance of leakage in the tubes depends mainly upon the care taken in the working of the locomotives; it may be safely said that locomotives, the tubes of which are fixed in the ordinary way, do not give any trouble if the fire is attended to in a regular manner, without abnormal entry of cold air into the box, and if care is taken to allow the boiler to cool off before being emptied, and more particularly before washing out with cold water. It is unwise to draw fires before an engine has been shedded, as the blast in this case draws a considerable volume of air through the fire-box and the tubes.

"12. Disincrustants may be found useful to obviate the formation of adhesive deposits; but their nature and proportions should be adapted to varying local conditions.

"13. The purification of feed-waters which contain much carbonate of lime, and particularly of selenitical waters, prior to their being used, is extremely desirable. The provision of plant for this purpose necessitates a heavy initial outlay; but the capital thus expended will often be recovered through economies of fuel, cost of washing out, and maintenance.

"14. The delivery of the feed-water into the steam space in such a manner that the steam quickly ejects from the boiler the air drawn in with the water, and that any local cooling of the plates be avoided, is worth a trial.

"15. It is not usually advisable to exceed a length of from 13 to 14¾ ft. for boiler tubes.

"16. The flue space should be as large as possible, which justifies the suppression of ferrules. The diameter of the tubes should not be too small nor should they be placed too close together. As far as possible it is advantageous that their internal diameters should be from 1¼ to 2 in., and their distance apart not less than 0.709 in.

"17. Ribbed tubes with an external diameter of from 2.36 to 2.75 in. are suitable for locomotives when the tubes are short. It may be found advantageous to substitute them for ordinary tubes of 2 in. diameter, with the same small diameter by suitably reducing the size of the ribs.

"18. The comparative effect between placing the tubes in checkerwise or quincunx rows as against vertical rows is not apparent; the preference, is, however, generally given to the latter arrangement.

"19. The nature of the metal in the tubes does not in any way affect the production of steam.

"20. The influence of varying the capacity of the smoke-box is inappreciable. Extension smoke boxes of American type, which have been tried by many European administrations, do not seem to give any better results than the ordinary smoke-box. It therefore appears advisable to retain the use of the latter arrangement.

"21. No evident superiority can be assigned to any particular form of chimney; those which are slightly conical in shape (of small diameter at the lower end) appear to be favored. It is advisable to prolong the chimney toward the interior of the smoke-box, giving this extension the form of a cone; the nozzle of the blast pipe should not be in this case much higher than the top row of tubes.

"22. No form of spark arrester can be said to offer advantages. All obstruct the draft without being absolutely efficacious; the ordinary spark arrester, made of wire, suffices in most cases.

"23. In the different systems of regulating the blast, the annular disposition appears to be slightly the best; it, however, becomes sometimes a little complicated if a variable section for the blast-pipe, though otherwise desirable, is adopted.

"24. All exhausting through single blast-pipes should be variable. The variation should not, however, be carried to such a point as to abnormally reduce the blast-pipe section; it is doubtless the lack of a suitable limit which has brought the use of variable blast into disrepute as being either injurious or useless. A simple mechanism with two controllable valves appears quite suitable.

"25. Attention may be recalled to the rule mentioned in paragraph 21 as to the height of blast-pipe; it should not be much higher than the upper row of tubes, even if the chimney is not extended into the smoke-box.

"26. Speed has no noticeable effect upon the production of steam; in other words, with equal weights of steam exhausted per second, and the same pressure in the cylinders at the start of the pre-exhaust, the greater or less frequency of the exhaust impulses is a matter of indifference. This fact is clearly proved by the action in service of two-cylinder compound engines."

EXPRESS LOCOMOTIVES.

By John A. F. Aspinall, Chief Mechanical Engineer of the Lancashire & Yorkshire Railway.

Mr. Aspinall has contributed a very elaborate report of 197 pages covering the following points:

A. Type of engine most suitable for high speeds.

B. The use of high pressure, and application of the compound principle.

C. Improvements in distribution, and balanced slide-valves.

D. Engine building regarded from the point of view of

diminishing the strain on the permanent way. The effect from this point of view of the compound principle.

E. Description of individual express engines.

This report is so long that we can only refer briefly to some of its principal features. For light trains and on roads with easy grades the author advocates engines with a single pair of driving-wheels, but for heavier grades and trains he says two pairs of coupled wheels are needed. "The maximum capacity of the locomotive boiler," he says, "is nearly reached. In America and in the continent, engines with much larger boilers can be constructed than in England, owing to the greater limits of the bridges and platforms in the respective countries." He gives some very interesting data with reference to the working of compound locomotives on the North Eastern Railway, which was furnished by Mr. Wilson Worsdell, the Locomotive Superintendent of that line. This data the author summarizes as follows: "The statement shows that 447 non-compound engines ran 14,807,261 miles with a coal consumption of 4,829,040 cwts., giving an average of 36.52 lbs. per mile; and that 395 compound engines ran 13,799,482 miles with a coal consumption of 4,122,239 cwts., giving an average of 33.45 lbs., or a saving of 8.40 per cent." No figures are given with reference to the loads hauled, but the results have been tabulated, and show that the maximum average saving in express passenger service in each of three years was 6.5, and the minimum 2 per cent. The maximum in "goods" service was 23.8, and the minimum 0.0. A report of the performance of Mr. Webb's compound express engine *Greater Britain*, which has already been published, is also given, with a report of an experimental trip with this same engine from Crewe to London, in which, with a train 3.96 times as heavy as the engine and tender, and with average speeds of 41.18 and 44.59 miles per hour, the consumption of coal was 1.719 oz. per mile per ton of train, including engine and tender. It may be remembered that the consumption by engine No. 999, as reported by Mr. Buchanan, in one test was 1.644 oz. Mr. Aspinall reports further that "on the Irish railways compounds have been experimented with by the Great Southern & Western Railway Company, also by the Belfast & Northern Counties Railway Company, and on the latter railway several compounds have been at work for some time with very favorable results. They have two cylinders, the Worsdell form of starting valve, and the Walschaert valve gear. The fuel used by these engines was South Wales coal, and the consumption showed an advantage varying from 11.17 per cent. to 17.74 per cent. . . . The working pressure was 170 lbs." Continuing on this subject in the report, it is said that "the highest boiler pressure recorded is that shown by the Paris, Lyons & Mediterranean Company, 219.9 lbs. per square inch; the North & Southern Railways of France having 198.6 lbs. per square inch.

"To obtain the best possible results from a compound engine, it has been found by experience that the high-pressure cylinder should be made at least 1 in. larger in diameter than one of the cylinders of a simple engine having the same power. At the same time the boiler pressure must be increased from 20 to 30 lbs. per square inch; and Mr. Worsdell, in his latest compound engine, No. 55, has gone still further and introduced 40 lbs. per square inch more than that used on the simple engines, No. 9, working in the same link. The total pressure of the compound is 200 lbs. per square inch, which is the maximum in this country, exceeding the American, and following very closely upon the French practice. This increase of pressure has also become necessary owing to the extra length and sinuous nature of the steam passages, and to overcome the resistance in the receiver. It must be remembered that the final pressure of the blast of a simple engine is of great importance, and also that in the compound the number of beats is reduced 50 per cent.; consequently, if the exhaust pressure is too low the efficiency of the boiler is reduced. By the adoption of high pressure the boiler and all steam joints must be made proportionately stronger, also lubricants having high flash points become necessary and the gland packing constructed to withstand the extra temperature. The latter point is not now of such serious importance, as the excellent systems of metallic gland packing which modern practice has introduced enable engines to run for even 12 months without repacking.

"From the foregoing statements it appears that a large and varying amount of fuel economy has been attained by the compound system, and the question now arises, Will it cover a reasonable interest on the extra first cost and repairs? In the matter of first cost it is probable that the high pressure will cause a corresponding increase in expenditure for boiler power. Excluding the latter, and when compounding is carried out by the aid of two cylinders, the expenditure should not be excessive, but when obtained by the application of three or more it may be expected to be greater. The simple engine is the product of years of accumulated experience, and, therefore, has this great advantage over the compound; but it is well known that the heavy repairs are carried out in the fire-box and boiler—the mechanism of the engine requiring the least attention. In compounding, higher pressures are required, therefore more frequent boiler repairs will be the outcome; but with regard to the other parts of the engine, they should not be excessive, and even those failures which have occurred may be attributed to untried designs. The general impression is that compounds are more economical in slow than fast running, which may be attributed to insufficient areas of the exhaust passages and the sluggish action of low-pressure steam. On the face of this it would appear strange that in this country there are more passenger than goods compounds, which is due to greater attention being devoted to the passenger engine, owing to the increased demands of the public. The principle has made less progress in this country than it has abroad, perhaps because it has a most formidable predecessor in the English simple engine, which is so economical and satisfactory in most respects. Undoubtedly the strongest argument in its favor points to its almost exclusive use in those countries where fuel is much more expensive than in England. On the continent and in America it appears to be gaining favor, if numbers are an indication; and the success of the Wordsell von Borries engines, as indicated by the Official Return of Consumption of Fuel on the Northeastern Railway and the continued and extended use of the Webb system on the London & Northwestern Railway, are strong points in favor of the system."

A very interesting table is given in which the ratio of heating surface to cylinder area and cylinder capacity, weight per H.P. of engine, etc., has been calculated for four-wheels-coupled engines on 45 different roads. This data is given under the following heads:

Area of two cylinders.*

Capacity of two cylinders.

Total heating surface to cylinder area—square feet to square inches.

Total heating surface to cylinder capacity—square feet to cubic inches.

Fire-box heating surface to tube heating surfaces.

Grate area to total heating surface.

Tractive force in pounds.

Tractive force to weight on driving-wheels.

H.P. at 15 miles per hour.†

Weight per H.P. of engine and tender in pounds.

It is to be regretted that the cylinder capacity for each foot or inch in the circumference of the driving-wheels and for each ton of adhesive weight was not calculated, because then the figures would have been comparable. As given in the table they are not. The heating surface per ton of adhesive weight would also have been more indicative of the relative proportions of the engines than the figures as they are now. Other similar tables are given, showing the proportions of six-wheels-coupled, single driving-wheel and compound engines.

A very elaborate series of tables giving the principal dimensions of 67 different engines on roads in all parts of the world will be very valuable for reference. Diagrammatic views and brief descriptions of the engines and the service in which they are employed add to the usefulness and interest of the report. These are followed by diagrammatic views of the trains hauled by the different engines, the weight of trains and profiles of the roads on which they are used. The report closes with a series of reproductions of engravings of locomotives, most of which have been published in English and other engineering papers.

The report contains an immense amount of data, but the reader will lay it down with a little disappointment that no more definite conclusions are reached; but perhaps they will be in order after the report has been discussed.

Station Working.

By George H. Turner, General Manager of the Midland Railway.

This report covers the following points:

A. Methods of accelerating the shunting of trucks and handling of merchandise. Arrangements of sorting sidings.

B. Employment of mechanical and electrical appliances in shunting and marshalling.

The report consists largely of a description of the methods employed in the Midland and other lines for handling traffic. The report is illustrated by engravings made from photographs, showing the way in which "wagons" are coupled on

* The area of the pistons is what is given.

† The tractive force and H.P. are worked out with the mean effective steam pressure in cylinders taken at 70 per cent. of boiler pressure.

English roads, several views of stations, and a number of plans of stations showing the arrangement of tracks, buildings, etc. Most of the methods and appliances described would be inapplicable to American roads. The arrangement, however, of what is called a "fan" of sidings for assorting wagons might, however, be studied with advantage by American railroad men.

SIGNALS.

Recent improvements in block and interlocking apparatus, chiefly from the point of view of economy in initial outlay. Signals in tunnels. Methods of preventing collisions at points of danger on express lines in case of overrunning stop signals. Replacement of color signals by geometric form signals, in order to avoid the dangers arising from color blindness or defective vision.

By A. M. Thompson, Signal Engineer of the London & Northwestern Railway.

This report consists chiefly of summaries of replies to 75 questions relating to signals, which were sent to various railways. These replies are, for convenience, arranged in a tabular form in an appendix. Information is also given with reference to the British Board of Trade requirements and the railway commissioners of New South Wales. In a note by H. Raynor Wilson, Signal Assistant to Engineer of the Lancashire & Yorkshire Railway, the advantages and disadvantages of lock and block on a busy line of railway are set forth, and a list of accidents, reported by the Board of Trade, are given, which the writer says would have been prevented if the lock and block system had been in use.

ORGANIZATION.

Organization of the central administrative and out-door staff on the various systems of different countries.

Two reports on this subject have been received, one of 260 pages, by G. Duca, General Manager of the Roumanian State Railways, and another of 23 pages by Frederick Harrison, General Manager of the London & Northwestern Railway.

In the first report the author has passed in review the systems of organization existence in continental countries of Europe, and the bulk of this portion of the report—219 pages—will indicate how minutely this has been done. In a few pages at the end he summarizes his "general considerations."

Mr. Harrison, in his report, deals with the subject under two heads as follows:

1. The railways of the United Kingdom of Great Britain and Ireland.
2. The railways of other English-speaking countries.

In drawing his conclusions he says:

"In the United Kingdom the directors delegate their powers for executive purposes directly to certain responsible officers, whereas in the United States the directors appoint a president and vice-presidents, and the president appoints the executive officers. The president appears to have somewhat larger powers than any single functionary on the railways of the United Kingdom; but this is, after all, a matter of detail, and does not vitiate the general principle. . . .

"In conclusion, I desire to observe that although organization on sound principles is necessary for the proper administration of a railway, as of any other undertaking, it is essential to the successful management of railways that it should enter thoroughly into detail. For this purpose a high standard of efficiency of the staff is the most important consideration. The rank and file must be carefully trained not only to carry out the duties allotted to each, but so as to develop their energies and intelligence; the strict maintenance of discipline and insistence on efficient work by subordinates of all grades, whether in carrying out instructions, the exercise of supervision, or the intelligent care of interests intrusted to them, and the utilization of the training experience and best intelligence of the staff, should be part of the responsibility of the heads of departments and chief officers. . . ."

THE TWENTY-FOUR-HOUR DAY.

Introduction in the time-tables of continuous reckoning from 1 to 24 hours, and of the division of the hour into 100 parts. Present state of the question. Partial adoption in different countries. Advantages to the public and to the railway service. Would the alteration of existing clocks be necessary, and if so, how could it best be accomplished?

By Mr. Scolari and Mr. Rocca, Chief Inspector and Inspector of General Management of the Mediterranean Railways of Italy.

The following topics are discussed in this report: History in brief; decimal division of time; the 24-hour notation; advantages of the 24-hour notation; objections to the 24-hour notation; the method expressing midnight; methods of applying the change; bibliography.

DECIMAL SYSTEM.

General adoption of the decimal system into calculations relating to the construction and working of railways.

Method of facilitating the introduction of the metric system of weights and measures in those countries where it is not already in use.

By I. L. Wilkinson, Chief Goods Manager of the Great Western Railway.

The writer, in his report, concludes that he does not see the way at present to recommend the adoption of a decimal system for the domestic business of the railways in England, but "sees no great difficulty in the arrangement of a standard of exchange for moneys, and in fixing equivalent values for weights and measures, to be used conjointly with the local bases of values of the various countries interested in the proceedings of the International Railway Congress."

LIGHT RAILWAY SHOPS.

Should the principal shops be in the middle or at one end of the line?

By Mr. Ferzi, General Manager of the Suzzara-Ferrara Railway.

The author draws the following somewhat colorless conclusions:

"The position of the principal shops of a light line cannot be fixed according to any general rule, because local circumstances greatly influence the choice.

"Apart from the advisability of placing the shops at the end or at an intermediate point of the line, it must be admitted that it is always preferable to build them at the station which, owing to passenger and goods traffic, is the most important, either because it is just at that point that it is necessary to keep the largest number of engines for shunting and strengthening trains and for use on specials, etc., or because it is much easier to establish repairing shops, find the necessary hands, and procure materials and insure the general superintendence of the service there.

"Still, no fixed rule can be laid down; and only by a most careful investigation of the circumstances involved in working a line and by calculating the advantages presented by one site over another will it be possible to decide upon the most convenient site on which to establish the sheds in any given case."

The discussions at this congress ought to be of very great interest, although, from the programme of proceedings, it now seems as though it, like all similar assemblages, will suffer from too much and too many entertainments. Excursions to various parts of England have been arranged, dinners are to be given, and when all these have received due attention there may not be much time left for anything else.

THE CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

THE twenty-eighth annual meeting of this Association was opened at Alexandria Bay, N. Y., at 9.15 o'clock on the morning of June 17, with President Garstang in the chair.

In his address the President placed particular stress upon the importance of forming a closer relationship between the employer and the employé as a preventitive of strikes, and suggested profit-sharing as a means toward that end.

The first report presented was that of fire kindlers, of which we present an abstract.

FIRE-KINDLERS.

This Committee reported fully a year ago on the devices for kindling fires that were then in use, but a resolution was passed continuing the Committee for another year, and asking that they gather all of the information possible on the subject. Little or no change has been made in oil-kindling devices, but a large number of experimental devices have been tried; but, as a rule, without marked success. The plan of introducing the oil-fire under the grates was tried with the belief that this was the proper place to light the coal. Heavy loss was caused by radiation from the ashpan, and the fire was not kindled as well as when the fire was applied above the fuel. Oiled waste has been tried, and independent kindlers, using a can of oil flowing by gravity to the kindler; but such devices are cumbersome, require more labor to handle, and increase the fire risks.

The cost of compressed air has never been charged to oil-kindler expenses, and we think that it need not be for purposes of comparison with wood, for the reason that there are expenses in handling wood fuel, not charged against it as fuel, that more than compensate for the cost of compressed air. By experiment it was found that a standard main air

reservoir containing 15,800 cub. in. of air at 70 lbs. pressure kindled three fires in ordinary eight-wheelers, using about 300 lbs. of fuel each ; this goes to show that the amount used is not excessive.

The officials of the Baltimore & Ohio, the Chicago, Rock Island & Pacific, the Wisconsin Central, the Burlington, Cedar Rapids & Northern, and the Minneapolis & St. Louis have made numerous experiments to determine the efficiency in time and cost of kindling fires with oil and wood under all kinds of conditions.

Both the Chicago, Rock Island & Pacific and the Burlington, Cedar Rapids & Northern furnish reports by months, showing the actual number of fires kindled for a year, with amount of oil used per fire and the cost of the same. These records, covering, as they do, a full year (61,768 fires), all kinds of weather, all kinds of locomotives, the fluctuations of oil prices, etc., can be taken as pretty correct, and they show that the cost of kindling locomotive fires by oil is less than 2 cents per fire.

Of the several devices tried, only one has come into anything like extended use. The Leslie kindler is in use in 407 stalls, and in course of installation in 428 more. All of the tests referred to were made with this device.

The Smith kindler is in use on the Illinois Central, but we have been unable to get any data as to its work, other than that it is doing well.

That the oil-kindler is past the experimental stage seems proven. There is no doubt of its efficiency. It saves labor and time, reduces fire risks, reduces hauling of fuel for kindling and storing and handling. Its cost—about $20 per stall—is easily saved in a year in economy over wood.

The Le Bel kindler is in use on the Canadian Pacific, the Fitchburg, and the Vermont Central. It is made up in the form of bricketts, 6 in. long by 2 in. wide and 1½ in. thick. It is composed principally of rosin, fuel oil, and sawdust. From four to 10 pieces are used to light a fire, the smaller number being enough for ordinary eight-wheeled engines. This kindler costs between 1 and 2 cents per stick ; comes in boxes of 100, and, of course, requires no plant. Being inflammable, it should not be stored in buildings on account of fire risks.

The following is one of a number of tests made on the Chicago, Rock Island & Pacific Railway to ascertain the difference in time in getting up 50 or 60 lbs. of steam, using the Leslie kindler and dry hard wood on the respective engines, with the blower used on both engines equally :

Standard Passenger Engine No. 936.			Standard Passenger Engine No. 937.		
Steam.	Hour.	Minutes.	Steam.	Hour.	Minutes.
10	..	48	10	..	55
50	1	36	50	1	48
With Blower.			**With Blower.**		
Temperature of water....68°			Temperature of water....68°		
Coal used.....454 lbs.			Coal used.....454 lbs.		
Oil used.....1½ galls.			Wood used.....⅛ cord, dry hard.		
Cost.....2.56 cents			Cost.....33 cents.		

The above test may be taken as typical of a number that are given in detail in the Committee's report, all of which go to show that the Leslie kindler is an exceedingly economical and efficient device. In another test made on the Chicago, Rock Island & Pacific Railway, a comparison of the amount of steam raised by oil and wood was obtained. Two standard passenger engines were washed out and filled with two gauges of water, and fired with an equal number of pounds of coal, one with one-eighth cord of wood, and the other with 1½ galls. of oil. The one using wood and 454 lbs. of coal generated a pressure of 98 lbs., while the one using oil and the same quantity of coal generated a pressure of 123 lbs. Crude oil was used and Illinois coal. The fires were allowed to burn out. Then follows a number of tests in detail, from which we find that the cost of kindling the fire with oil ranged from .75 to 5.40 cents each ; for wood it ranged from 19.25 to 56.25 cents each, and for waste from 11.8 to 17.6 each. As these are all special tests, they may be looked upon with suspicion, in that the difference is so great in favor of the oil ; but in order to set aside any such thoughts and to show that it is really due to the merits of the oil method, the record of the Chicago, Rock Island & Pacific Railway for a year is particularly interesting and valuable. This report shows that during the twelve months ending June 1, 54,094 fires were kindled at an average expense of 1.77 cents each, and a similar report from the Burlington, Cedar Rapids & Northern Railway shows that 7,674 fires were kindled at an expense of 1.97 cents each. Such a report as this should certainly go far toward convincing locomotive superintendents that oil is what they should and must use.

In the discussion following it, Mr. Atkinson said : " I have had some experience with the Le Bel kindler and made several tests. I have also made tests with oily waste and succeeded with the blower in getting up steam, about 70 lbs. in about one hour and a quarter. So far as I have tried the Le Bel kindler it has worked well. It did not work well at first, but we did not know how to use it. We put the kindler below the coal ; we afterward found it was better to make a mound of the coal and put the kindler on top ; and being of a resinous nature, when lighted it spreads down through the coal. I made a test between two engines, one with the Le Bel and one with wood, cold water in each case, and engines in same condition as far as we could get them ; it was considered that we should debit the Le Bel kindler with the cost of some coal. I found in the course of the experiment that we had to put the same amount of coal in in each case. It was not a question of raising steam ; it was one of getting the body of fire ready to go in service. I put 600 lbs. of coal with five sticks of the Le Bel kindler in the fire-box of an eight-wheel engine, 300 lbs. of coal at the beginning, and balance afterward. By the use of the blower, 70 lbs. pressure, we got first steam in 53 minutes ; 70 lbs. of steam in 78 minutes ; 120 lbs. of steam in 87 minutes. At that time the 600 lbs. of coal formed a body of fire about 4 in. thick on the grate, and the engine immediately proceeded to a train. In the other case, the lighting with wood, we used 95 lbs. of the best dry pine, scantlings and edgings, without sap, wood or bark. We put 300 lbs. of coal on to commence with, and afterward 200 lbs., making a total of 500 lbs. We got first steam in 37 minutes from time of lighting, 70 lbs. of steam in 57 minutes, and 120 lbs. of steam in 69 minutes. The coal fire was then very thin, and it was found necessary to add another 100 lbs. of coal, and wait until it ignited, before the engine was fit to move out and take a train."

Mr. Brown : We take it for granted that the roads using kindlers are using soft coal ; it ignites pretty freely. We are using hard coal, and I do not think we could obtain very great benefits from such a little flame in the first place. Our experience during the past 28 years has been lighting with wood in the usual way, and covering it slightly with coal, and allowing it to ignite as easily as possible, so as not to increase the heat on the plates too suddenly. Previously live coals were used for starting the furnaces. We had a furnace, in which we burned coke, and when we wanted to start a fire in the engine, we would run in a couple of shovelfuls in the centre of the fire-box and cover it with coal. It is an easy matter to ignite soft coal.

The noon hour of the first day's session was occupied in the discussion of the topical question : Which is safer construction for a ten-wheel engine, swinging centre trucks and flanged forward drivers or rigid trucks and blind forward drivers ? It appeared, from what was said, that a blind forward driver would be a dangerous thing ; but it would be difficult to tell whether a flange on the main driver is an advantage or not. The preponderance of opinion probably inclined toward the use of the flange, but excellent and satisfactory results are obtained without it, and there were no cases of derailment resulting therefrom reported.

There was a long report and a lively discussion on the subject of the bulging of fire-box sheets. In the report the committee gave the results of their investigations, and gave as an opinion that the bulging was usually caused by an accumulation of mud or scale, causing an overheating of the plates, the same effect being produced in some cases by contracted water spaces. Mr. Soule summed up the report and discussion by saying that he " gathered from the discussion and report that there are four principal causes which result in bulging fire-boxes—concentrated action of the fire, insufficient width of the water space, formation of scale on the sheets, accumulation of mud in the leg. I do not think we can improve the handling of our fires. Mr. Vauclain has thrown out the hint that the best escape from that trouble would be in the direction of enlarging our fire-boxes. As regards the width of the water leg, we are tied up there ; we are in between the wheels in nine out of ten engines, and cannot widen that space without reducing our grate area, which would be an evil in the other direction. As regards the formation of scale on the inside of the sheets, it makes me tired to think of the experience we have been through in that matter, and all the experiments that have been made

with different boiler compounds. That brings us down to the matter of mud, and to my mind our best chance for escape from these troubles lies right there. What we need is to have in every round-house where engines are handled in considerable numbers powerful pumps, with a plentiful supply of steam, so that we can go at the business in a sensible way, washing them thoroughly and frequently, throwing into them a large volume of water at high pressure."

In the report and discussion on the Best Material for Boiler Tubes, there was a unanimous sentiment in favor of charcoal iron, the following being a brief abstract of the report.

Circular letters were issued to members of the Association, asking for information, based on experience, in the use of boiler tubes made of different materials now in use, with a view of embodying in this report the views of those most interested. From replies received we find that all prefer iron and recommend it as the best material for locomotive tubes. The objections offered to the use of steel tubes are that they are more liable to "pit" and become eaten out sooner than iron, and in localities where water is bad there is greater difficulty in keeping them tight. The ends soon become hardened from frequent rolling and calking, which makes them so brittle that they break off at the fire-box end.

Some master mechanics report trouble from imperfect welds in the use of steel safe-ends with tubes, and *vice versa*. This arises from the fact that the melting point of steel is materially lower than that of iron, so that when iron is brought to the welding heat, steel is burned. Steel safe-ends may be perfectly welded to steel tubes, and iron ends to iron tubes; but when tubes and ends of different materials are joined, imperfect welds will result. It is, therefore, very important that tubes and safe ends be of the same composition. In recent years it appears that manufacturers have attempted to make a specialty of steel tubes, and the market is supplied with steel tubes, tubes with part steel at centre of the section, tubes with one side of steel, and tubes are offered, made by various processes, of both iron and steel.

The committee also recommended a set of standard specifications which are practically the same as those used on the Louisville & Nashville and the Chicago, Milwaukee & St. Paul railroads, the use of the etching test being especially recommended for determining the quality of the metal. In a topical discussion at the noon hour of Tuesday it was gathered as a consensus of opinion that the adjustable driving-box wedge is not a necessity, and that results that are perfectly satisfactory have been obtained with fixed wedges.

The report on Gauges for Sheet Metal was read and received without comment.

GAUGES FOR SHEET METAL TUBES AND WIRE.

If the recommendations made by this Committee produce the results that is hoped for their labor will not have been in vain. Their purpose has been to establish a gauge for thin metals that will take the place of the numerous gauges that are now in use, and whose numbers are not only confusing to the uninitiated, but puzzling even to those who make frequent use of them on account of the entire lack of association between the numbers and the actual sizes that they represent.

To this end your Committee opened communication with a similar committee of the American Society of Mechanical Engineers, and after much correspondence a joint meeting of the two committees was held at Hotel Lafayette, in Philadelphia, on November 7, 1894, when the following resolution was passed:

"*Resolved*, That we, the members of the Joint Committee of the American Society of Mechanical Engineers and the American Railway Master Mechanics' Association, earnestly deprecate the use of any of the numerous wire and sheet metal, or other gauges.

"In practice we recommend the use of micrometre calipers or notched gauges, the latter with notches of dimensions suited to the convenience of the different industries, and, where necessary, different selections of sizes in thousandths of an inch, suited to each trade, being incorporated in their working gauges; provided, however, that these are always dimensioned in thousandths of an inch, and marked in terms thereof, the number of thousandths being marked opposite each gauge notch, thus, .001".

"We further recommend that the members of the various engineering societies assist the introduction and general adoption of this system by using it in their own work."

(The American Society of Mechanical Engineers' Committee reported this resolution to their Society at the December meeting in New York, and also stated that the movement was gaining ground in Europe and Canada, the French Government having already abolished the arbitrary gauge, making a decimal metric system the legal measurement.)

Immediately after this joint meeting, your Committee sent out circulars of inquiry to members of the Association and manufacturers, asking for their views relative to establishing the decimal system, and submitting a list of sizes which it was proposed to include in the solid notched gauge, and giving for convenience the nearest equivalent in the Birmingham gauge.

In order to show the confusion that really exists they give a scheduled list of 25 gauges in tabular form for the purpose of comparison, and a formidable array it does make. They have, however, received a great deal of encouragement from those who have taken the trouble to reply to their circular of inquiry, as these answers were almost unanimously in favor of the adoption of the decimal gauge. After receiving these replies another joint meeting of the two committees was held, when the following resolution was unanimously agreed to:

"*Resolved*, That while the micrometre gauge should be used for test purposes in the laboratory, yet for general shop use a solid notched gauge is desirable. The form of this gauge should be an ellipse whose major axis is 4 in., the minor axis 2.5 in., and the thickness .10 in. There should either be one hole .75 in. diameter in the centre, or one at each of the foci for lightening and convenience. This gauge must be plainly stamped with the words "Decimal Gauge" in letters .200 in. high, and below this the name of the trade which the group of notches is to cover; these groups to be selected with reference to the needs of the several trades.

"All sizes of notches to be marked in thousandths of an inch without a zero prefixing the decimal point, but with inch-marks after the figures, thus, .002".

"It is also the intention of this Committee that in ordering material, the term "gauge" shall not be used, but merely the thickness in thousandths of an inch."

The object of the elliptical form is to permit a ready distinction from the old-style circular or rectangular gauges now existing, and also to make it more convenient for the vest pocket.

As explained in the resolution of November 7, 1894, various trades may have different groups of notches to suit the necessities of each, but as all notches will have the dimensions given in thousandths of an inch, there can arise no ambiguities, as similar notches will have the same designation on any one of the gauges; thus .085" would mean the same whether on the master mechanics', tinners' or glass manufacturers' gauge.

We now have to recommend to this Association for its adoption as standard:

1. The micrometre caliper should be used for laboratory and tool-room work, and in the shop when specially desired.

2. The solid notched gauge should be used for general shop purposes.

3. The form of this gauge shall be an ellipse whose major axis is 4 in., the minor axis 2.5 in., and the thickness .1 in., with a central hole .75 in. in diameter.

4. The notches in this gauge shall be as follows:

.002"	.004"	006"	.008"	.010"	.012"	.014"	.016"	.018"
.020"	.022"	.025"	.028"	.032"	.036"	.040"	.045"	.050"
.055"	.060"	.065"	.070"	.075"	.080"	.085"	.090"	.095"
.100"	.110"	.125"	.135"	.150"	.165"	.180"	.200"	.220"
.240"	.250".							

5. All notches to be marked as in the above list.

6. The gauge must be plainly stamped with the words "Decimal Gauge" in capital letters .2 in. high, and below this the words "Master Mechanic."

7. In ordering material, the term gauge shall *not* be used, but the thickness ordered by writing the decimal as in above list. (For sizes over ¼ in., the ordinary common fractions may be used.)

We appreciate the fact that the standards are practically worthless unless the members put them into everyday use, and we heartily urge them, not only to indorse these recommendations, but to use them.

The Pratt & Whitney Company, of Hartford, Conn., offer to furnish the Solid Elliptical Gauges, notched as shown in the cut, for $5 each, if the use of the gauge warrants their making the necessary tools for their production.

UTILIZATION OF RAILROAD SCRAP MATERIAL.

Your Committee upon the subject of the "Utilization of Railroad Scrap Material, and the Best Method of Handling the Same," begs leave to submit its report as follows:

It is proper to state at the outset that some little difficulty has been experienced in attempting to gain a full expression of facts and opinions from members, owing to the fact that some members consider it unnecessary, if not improper, for a railroad to have any scrap pile at all. This is, of course, based upon the use of the word "scrap" as synonymous with "junk." It has seemed to your Committee that this was not

the meaning intended to be conveyed by the wording of the subject, else there would be no question of the utilization of scrap on the part of the railroads. "Scrap" has therefore been treated as occupying an intermediate position between second-hand material and junk. It may be one or the other. It is more commonly both.

The subject naturally divides itself into the two heads suggested in the title—Handling and Utilization.

The first will include gathering, sorting, and arranging, with reference to possible future use or for sale.

The second—and in treating this branch of the subject it has seemed desirable to depart from the common practice of tabulating replies, for reasons that will be stated later on—will include the results of the experience of members in working over second-hand material.

HANDLING SCRAP.

Your Committee has found it impossible to formulate any rule for the handling of scrap which shall be capable of general application, owing to the varying conditions prevailing upon different roads. For instance, many railroads have shops of all kinds located at a single point.

Others have shops at several widely separated points, and in many instances the shops relating to the locomotive department are entirely separated from those of the car department.

The distance of any of these shops from each other, or from the scrap market, taking into consideration the cost of transportation, also has an influence. It is believed, however, that the suggestions which are applicable in the case of a single central plant may have a partial bearing upon the several smaller shops of a system.

In the case of a single plant, the collection will consist only in bringing to this central point all the various articles of scrap materials accumulating upon the various divisions, and such as are picked up along the right of way. With several smaller shops, it would seem best that each should be treated in the light of a central point. By this it is meant that the scrap naturally belonging to it or accumulating in its vicinity should be sorted with reference to two general classes—viz., that which is of probable future use at that point, and that which cannot be utilized at that point. The latter should be shipped to the principal shops for sale or for utilization there.

It is suggested by one member that such scrap as is obviously of no use, except for sale, may be kept on hand until there is such an accumulation as to enable handling in carload lots. With this exception it would seem that the treatment to be followed in both cases should be substantially similar.

As the material is unloaded from the car it may conveniently be handled under two classifications—as to material, and as to future disposition. This should be done under competent supervision. The first classification may be as finely subdivided as the circumstances in each particular case seem to indicate, but should at least cover the several metals found.

The second classification may cover, first, material that can be used again, and is therefore plainly second-hand material only; second, material that can be used again, but which requires additional work or preparation before using; and, third, material that can only be sold as scrap. The conditions in each case will govern the amount and kinds of material that will be retained or sold, whether it be all or none.

It will be noted that the plan suggested, and which is made up from items of the practice of several members, provides for a double inspection of the scrap material, and for the turning into stock of material that may be used again without preparation.

This naturally implies a separation of the material at the main scrap pile into other classes, according as the parts belong to cars, locomotives, or the roadway, from which the proper credits may be determined for the several departments.

Only one of the members has suggested the arrangement of bins. This is that they may be placed upon a long platform upon a level with the car floor, and about 6 or 8 ft. from the edge of the platform. The man in charge instructs the laborers in which bin to deposit the various classes of material.

As previously mentioned, and as stated in one of the replies to your Committee's circular, "circumstances and conditions with the different railways are so diverse that each one separately must be governed by the economic features presented in its location, considering carefully prices of new material, scrap values, transportation, and handling."

Your Committee is, however, of the opinion that if a road is in position so that it seems desirable to handle scrap material to any extent, a careful supervision by one capable of exercising sound judgment will be found to be an economic measure. The general principles which may well govern the management of the whole subject have been laid down in a paper read during the past year before one of the railroad clubs. They are as follows:

First. The scrap pile should be in charge of persons of as much intelligence as is required for any position on the railroad.

Second. The method of handling the scrap material which is to be put to further use should be as systematic and carefully elaborated as that of handling new material.

UTILIZATION OF SCRAP.

In the matter of the utilization of scrap material, after it has been sorted and so arranged that systematic use is possible, it has seemed best to your Committee, in view of the variety of uses to which various parts of cars and locomotives may be put, to present, in a condensed form, the experience of the members who have reported. It is somewhat disappointing that, with the exception of one or two instances, there are no figures upon which to base a report as to the difference between the cost of working over old material and the price of the new. This is partially accounted for by the fact that most mechanics would use new material in preference to working over old, were it not that the latter course is, in a measure, unavoidable.

It appears to be a fact, also, that there are few instances in which scrap and scrap accounts are kept so systematically that figures even approximating accuracy are possible. For the benefit of such as prefer or are obliged to devise methods of utilization of such material as is at hand, the various suggestions given may prove of some value.

Many classes of scrap may be conveniently used without passing through the foundry or the rolling mill. Bolts may be cut off, straightened, and recut. As the bodies of bolts are seldom injured beyond bending—if broken, the breakage is their condemnation—this practice may be continued indefinitely, or until the length is so reduced that they will answer only for track bolts.

One member carries the process still further, and when the bolts are too short for use as bolts, they are used as rivets. A method of treatment of old bolts is suggested, to place them over night in a heating furnace, which serves the purpose of annealing and causes the hard scales to drop off when they are straightened under the hammer. It also softens the metal and saves wear upon the bolt-cutting dies. A saving of about 1¼ cents per pound is claimed for this course of treatment compared with the cost of new bolts. Small bolts are cut down and made into lag screws at a saving of about 2 cents per pound. One member reports 40 per cent. of all bolts as made from old material.

Nuts may be closed up and recut. It has been suggested that they should be pickled in a weak solution of hydrochloric acid, to remove rust and prevent undue wear of taps.

A large proportion of the wrought iron which finds its way to the scrap pile can be utilized, provided it has been so sorted that suitable pieces for any special purpose can be found without the expenditure of so much time as to neutralize the apparent economy.

Arch bars, brake connections, brake staffs, bottom straps, drop-door hinges, door slides, etc., are of such section as to be capable of use as carry irons, truck hangers, brake-jaws, brake forks, straps for coal cars, etc.

Bridge iron and old iron turn-tables furnish material for repairs to locomotives and tenders. Turn-table plates serve for cross bracing for tender frames, and the channel iron of old bridges will make tank frames and bolsters.

Truss-rods may be used by welding on new ends, or, when past this point, may be cut up for various purposes, as bolts or brake connections.

Tank and boiler-sheet scrap may be used for ash-pan sides and ends, bumper beam plates, wheel covers, large sizes of washers, shoveling sheets on tank floors, floor sheathing under forges, bridges for freight-house platforms, shims, liners, slides, etc.

Links and pins, if not too badly bent or worn, may be straightened and returned to stock. The consensus of opinion is to the effect that welding of such parts is not in the line of economy, though in many instances broken links are welded, and, if circumstances require, standard gauge links may be readily converted into links for narrow gauge. Old links and pins are made up into hammered iron for side and main rods, engine links, etc.

Coil springs may be utilized by mating an unbroken inner coil with an unbroken outer part. The life, however, will be short, as the elasticity has probably been impaired. Pieces of broken coil springs of large size may be used for pinch bars, jack-levers, and buggy bars for engines.

Flat or semi-elliptic spring leaves may be used for repairs

to other springs, rod liners, equalizer rigging, keys, plates, and spring clips, small wrenches, brake-beam guide springs for passenger-car trucks, drawhead keys, side plates for split switches, etc.

Old flues are sometimes used to advantage in making drain gratings under water tanks, for cattle guards, over cinder pits, etc., and for ash-pan and other split keys. In this case they are flattened and punched to the required shape under the steam hammer. One member calculates a saving of 50 per cent. in using flues for cinder-pit gratings. Flues also make excellent material in the manufacture of whistling and crossing signs, and for fences about depots and grounds.

Scrap axles are used for a variety of forgings, such as equalizers, pedestal and frame braces, brackets, mud-rings, smoke-box rings, equalizer fulcrums, arch bars, drawbars for engines —both front and back, swing-beam hangers, Miller hooks, truck frames, engine and tender chafing plates, wrenches, piston-rods, crank and rod-pins, main and connecting rods, rod-straps, etc.

One of the members of your Committee utilizes narrow-gauge axles, which are straight in the centre, by cutting off the journal ends and cutting the middle part in two pieces. By welding three such pieces together, making two new out of three scrap axles, a considerable economy has been developed.

Old axles may frequently be worked into virtually new axles, which come up to the original standard in strength and elasticity. A good method, where there are suitable facilities, appears to be to roll the old axles into bars $3 \times \frac{1}{4}$ in. and cut into 3 ft. 6 in. lengths. These plates are placed together in sufficient numbers to make the axles required. By this method the particles seem to become elongated and produce fibrous metal capable of enduring ordinary tests and service.

Old hand-car axles are used to make crank axles on new hand-cars, at a saving of $1.25 on each axle. Surplus stock of this class is made up into fence-posts along the right of way.

Piston-rods, hand-car axles, small car axles and main rods can often be conveniently used for the motion work of the locomotives, being case-hardened after finishing.

Upon one road old steel driving-axles are used over again at a reduced size, being annealed by wood fire during the several stages. For instance, an 8-in. axle is reduced to serve at 7½ in., then at 7 in., and finally at 6½ in., that being the smallest size used. From this stage it is made into crank-pins, and from that to blacksmiths' tools. Old steel tender-axles are used awhile as engine-truck axles, and finally end in the same manner. Guide yokes are sometimes made from iron axles.

Old tires are in some instances converted into rod straps for engines, filling pieces for frog points, and blacksmiths' tools. Your Committee have no figures upon the economy of working up old tires, with the exception of the experience of one member who found that the cost of some hand-hammers made of old Krupp tire was $8.98 per dozen, as against $4.50 per dozen for new hammers. He discontinued the operation.

However, at the same shop, coal hammers, lining-bars, claw-bars, and some classes of wrenches have been made at a profit from the same material.

Fish-plates are successfully converted into rail braces at a cost of a cent apiece.

Worn-out steel rail is converted into brake-beams by working out the head of the rail to the same thickness as the web, leaving the base in its original shape. This is then sheared to the proper shape, making a good beam out of worthless material at a cost of about 40 cents for labor.

There is such a variety of uses to which a large part of the scrap pile may be put, that it seems unnecessary for your Committee to enumerate more. It is understood, however, that the handling of scrap must be carefully regulated, or the apparent economy will be entirely lost in the increased time expended in looking for a suitable piece for any special purpose. It is also to be understood that such parts as are capable of being worked up for any well-defined purpose should be so treated at the earliest opportunity, and the completed article turned into stock in the same manner as is new material.

In the matter of some classes of material it is easy to throw away time and money in trying to save it, but a discriminating man can usually save his salary several times over in the work of scrutinizing what comes to him as scrap, and taking measures to save the good material and get rid of the bad as quickly as possible.

There was a long discussion on the report concerning piston heads, each member evidently having had his own trials and tribulations with broken rods. The Laird cross-head was especially condemned; and it was the universal opinion that the shoulder at the cross-head end should be dispensed with and that a great deal of the difficulty arose from the high speeds at which the reciprocating parts are run.

PISTONS, PISTON-RODS, AND FASTENINGS.

The Committee having this subject in charge made a long report that consisted for the most part of descriptions of the three types of pistons that are now used on American locomotives, winding up this portion with a list of weights of pistons of various sizes that are used. In regard to piston-rods, the inquiries of the Committee have led them to the conclusion that the taper fit for both ends of the piston-rod is well supported by successful practice, and may be considered as the standard arrangement. There are a considerable number of details which, however, may seriously affect the results in service. "It seems to be pretty well proven that a square shoulder between the taper fit and the cylindrical portion of the piston-rod (at either end) is a bad arrangement, as it localizes all bending strains at such a shoulder and invites fracture at that point. This is getting to be pretty generally recognized, and is overcome in either of several ways; the first and most obvious way being to introduce a large fillet in place of the square shoulder; the next step being to introduce a blunt taper in place of the square shoulder; the next step being to carry the original taper out beyond the piston or cross-head fit and until it merges into the cylindrical surface of the piston-rod itself. Still another recourse is now being availed of to a considerable extent, and consists of reducing the section of the piston-rod for a short distance outside of the cross-head fit (this is never done at the piston fit), which arrangement still further tends to relieve the cross-head fit itself from bending strains (and consequent tendency to get loose), and localizes those bending strains in a reduced cylindrical section, which is well adapted to receive and absorb them. This practice has been more extensively followed on the Michigan Central Railroad than anywhere else, and is said to have resulted in an almost complete freedom from broken piston-rods. The same idea carried to a further extreme is to reduce the entire length of the piston-rod between the piston fit and the cross-head fit to a diameter less than that of the large end of the taper fits themselves, but this entails the necessity of using a split stuffing-box, which by many is considered to be very objectionable.

"The usual and preferred method of fastening the piston-rod into the piston is by a nut. Experience has shown that it is important that this nut should be sufficiently thick to prevent any possibility of its threads being battered by the blows on the piston, which action would, of course, result in the nut becoming loose and the fit between the piston and piston-rod becoming impaired. A few roads use a brass nut in this place, claiming that a forged iron or steel nut gives trouble from rusting, and in some instances has to be split before it can be taken off. A very few roads dispense with the nut entirely; the end of the taper fit of the piston-rod being riveted over into a countersunk recess in the faces of the piston itself. It is usual to take the further precaution in such instances of inserting a key through the hub of the piston and taper fit of the piston-rod."

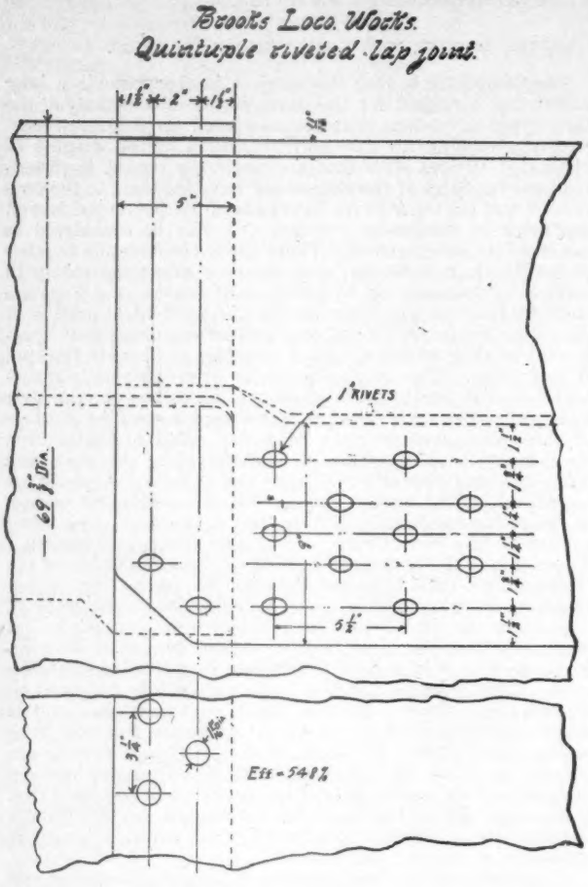
In handling the packing-rings the Committee give a list of the various widths of packing-rings that are in use on a number of roads, and it is interesting to note the wide variation in the dimensions of rings that are to do the same work. In one instance they are 1 in. wide in a 16-in. piston, and in another only ¼ in. wide on one 19-in. in diameter. The probability is that those master mechanics who are using wide rings have not noted the gradual reduction in the width that has been going on for some time, and still use the old sizes without having given the matter much thought. It is evident, however, from indicator cards that there is no more perceptible leakage past a ¼-in. ring than there is past one of double its dimensions.

The conclusions drawn by the Committee in closing its report are as follows:

"That for pistons of moderate diameter and for use in slow-speed engines, there is an open choice between the bull-ring form and box form, while for pistons of any diameter, if for high-speed engines, the single-plate type presents the important advantages of lightness combined with strength. In piston-rod fastenings the taper fit with nut at the piston end and key at the cross-head end seems to be the arrangement which is justified by the best practice. The tapers which are in current use vary between the extremes of ⅜ in. in diameter in 12-in. length to 1½ in. in diameter to 12-in. length, while a fair mean representing average practice may be considered to be 1 in. in diameter in 12-in. length."

RIVETED JOINTS.

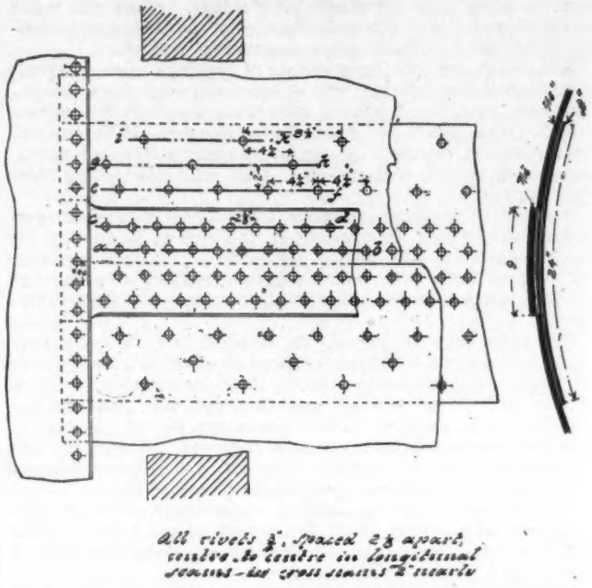
The estimate of the value put upon this report will depend upon the attitude that is assumed toward it by the reader or



Sketch No 9

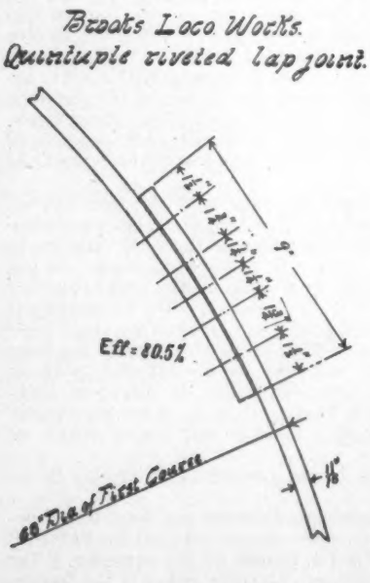
listener. If the former takes it up in the spirit of the student that is searching for information, he will probably find therein a compilation of the best researches on the subject, and will be content; but if the report is thrust upon him as a listener, he will probably become quickly confused in the rapidly succeeding series of mathematical formulæ, and find that the limit of his intellectual elasticity has been so far exceeded that when the subject is thrown open for discussion he has but a vague idea of what has been said, since the training of this average listener does not include a course in the mental solution of problems in higher mathematics. While the report is a valuable compilation for the student, it should be read in abstract from which all of the mathematics have been abstracted.

Sketch No 26



All rivets ¾", spaced 2½ apart centres. Centre to centre in longitudinal seams - two cross seams 8" centre

The report starts out with the assertion that the Committee "decided to make this report elementary," and then proceeded to define the various terms of boiler nomenclature. All sorts of joints were defined, a name was given to every conceivable strain to which a rivet or a joint or a plate can be subjected, and this done, as a sort of preliminary canter, the symbols are lined up and started over the course. In the early portion of the report there is no evidence of any original work on the part of the Committee, other than the gathering in of the results of the investigations of Unwin, Reuleaux, and Haswell. This to be sure is well done, and deserves the appreciation and thanks of the student.



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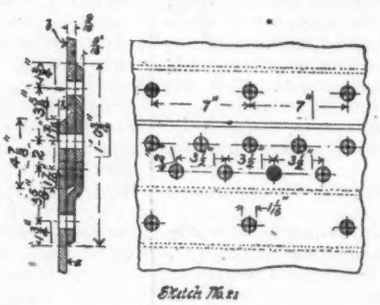

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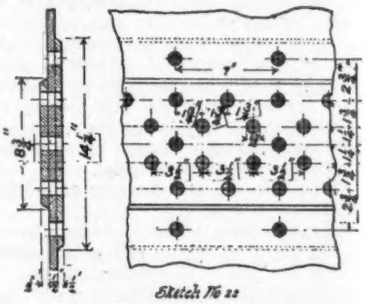

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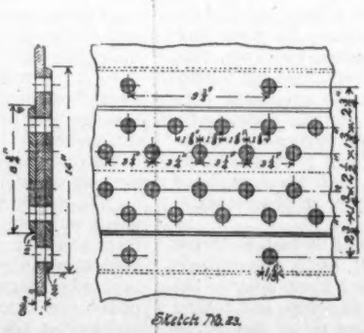

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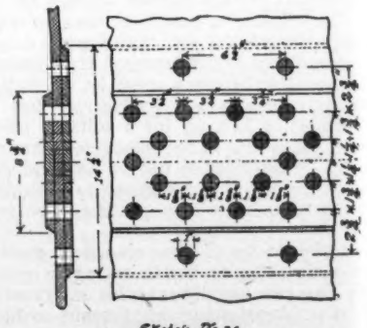


Sketch No 24

Occasionally there is an oasis in the shape of an empirical assertion where the non-mathematical listener can rest for a moment, until he follows the caravan to the next green spot. The first appears in the form of a rule for ascertaining the force required to break through the margin of a riveted joint,

which, being interpreted, may be made to read, "take the continued product of four times the tensile strength of the plate per square inch, the thickness of the plate in inches, and the square of the margin in inches and divide the result by three times the diameter of the rivet in inches, and the information sought is your own."

Again: "For shells $\frac{7}{16}$ in. thick or over, the thickness of the tube-sheets should be $\frac{7}{16}$ or $\frac{9}{16}$ in. For shells less than $\frac{7}{16}$ in. thick, it is good practice to make the tube-sheet $\frac{1}{16}$ in. thicker. The thickness of the outside door sheet should be the same as the thickness of the part of the shell of largest diameter.

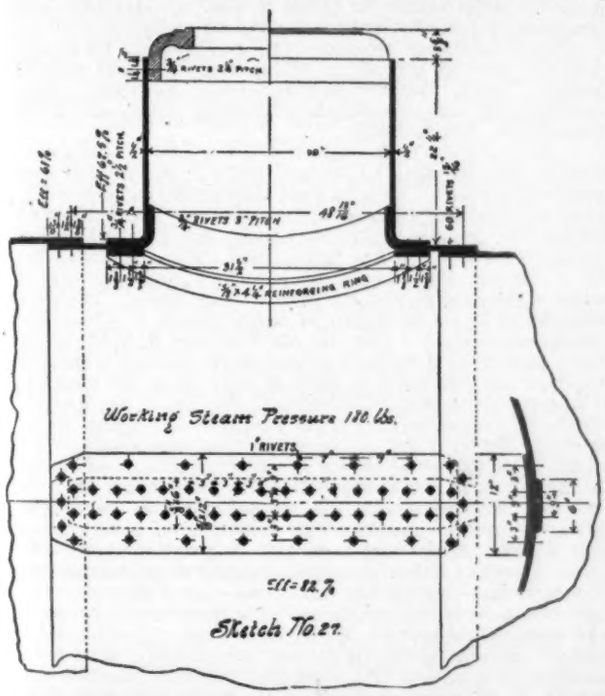
"The throat-sheet should be made $\frac{1}{16}$ in. thicker than the shell, to allow for the thinning produced by flanging.

"With shell plates $\frac{7}{16}$ in. and over, the throat-sheet may be made only $\frac{1}{16}$ in. thicker than the shell-sheet, and in some cases has been made no thicker than the shell-sheet.

"The fire-box throat-sheet, if separate from the back flue-sheet, should be of the same thickness as the fire-box side-sheets.

"If but one welt is used with a butt joint, the welt should be from $\frac{1}{16}$ to $\frac{1}{8}$ in. thicker than the main plates. A welt used with the lap-joint should be as thick as the main plate. Welts used with a butt joint (on which two welts are used) may have any thickness between five-eighths of and the full thickness of the main plates. The thicker the welt the more permanent the calking.

"The rivet holes should not be over one-sixteenth larger in



diameter than the normal diameter of the rivets, and the calculations of the strength of the rivet should be based on its driven diameter, which is the diameter of the hole."

In discussing the matter of materials, the report says:

"It has now become the universal practice to construct locomotive boilers of steel. As this Association has proposed, and adopted a standard specification for boiler and fire-box steel plate, in which the minimum limit of tensile strength is 55,000 lbs. per square inch, we shall base our calculations upon this figure.

"All of the railroads that have replied to the questions of our circular of inquiry report that they use iron rivets, and the contract locomotive works which have replied recommend iron rivets and use them in boiler construction, unless steel rivets are specified. The only objection which your Committee has to the use of steel rivets is that there is danger of overheating them in the hands of the rivet boys usually employed for this work, in which case their strength is materially diminished. It may be said further that it is usually not difficult to obtain sufficient shearing strength with iron rivets in a well-designed joint.

"From the United States Government tests of riveted joints, made on the Emery testing machine at the arsenal at Watertown, Mass., we find that 38,000 lbs. per square inch is a fair average value for the shearing strength of rivet iron in riveted joints. In the tests of riveted joints made for the Pennsylvania Railroad at the Watertown arsenal in April, 1886, and March, 1887, the rivet iron showed an average shearing strength of about 43,000 lbs. per square inch in the joints that failed by shearing. Of course, if a particular kind of rivet iron is used the shearing strength of which is known to be greater or less than 38,000 lbs. per square inch, the actual shearing strength of the iron should be used in proportioning the joints in which that kind of iron is to be used for rivets, and if steel rivets are to be used, a shearing strength of about 50,000 lbs. per square inch may be allowed.

"Moreover, the method by which the rivet holes are made in the boiler plate also affects the tenacity of the net section of the metal. If the holes are drilled, or punched $\frac{1}{8}$ in. smaller than the finished size and reamed, or punched to size and the plates are annealed thereafter, the net section of the plate shows increased tenacity, the proportion of increase depending on the thickness and hardness of the plate and the pitch of the rivet holes. If, however, the plates are punched to size and the plates are not annealed after punching, there may be excessive tenacity, or there may be a deficiency of tenacity in the net section of the plate. Punching alters the structure of the metal immediately surrounding the hole, and makes the net section of plate non-homogeneous. This weakens the net section of plate, and the weakening thus produced may more than neutralize the excess in tenacity produced by the grooved specimen action.

"Your Committee recommends either that punched holes shall be reamed or that the plates containing them shall be annealed after punching. If this becomes the practice, there will always be excessive tenacity in the net section of plate. The amount of the excess cannot be determined without recourse to experiment, and in deducing the dimensions of the joints which we recommend to you, we have not allowed anything for this increase in strength.

"Moreover, it is our opinion that such excess should not be counted upon unless it is shown to exist, and its magnitude is determined by experiments upon joints which are *identical in every respect* with those for which allowance is to be made.

"There is also a certain amount of friction between the adjacent plates in a riveted joint, caused by the longitudinal stress in the rivets, which stress is induced by the method of driving the rivets and by the contraction of the rivets by cooling. While the friction between the plates is capable of resisting or neutralizing some of the tension which the joint bears, it is the opinion of your Committee that it should not be considered as an aid to the strength of the joint. Concerning this, Professor Unwin says: 'English engineers entirely neglect the friction in estimating the strength of the joint, the reasons assigned being that the amount of tension in the rivet is not ascertainable, and that vibrations and other causes tending to slightly elongate the rivet may, in course of time, destroy it altogether.'

"When rivets are driven in punched holes we consider it good practice to have the smaller diameter of the holes come together, because the rivet fills the hole more completely than it would if the holes came together in any other way, and the upsetting of the rivet tends to draw the plates together.

"Thoughtful consideration will show that with a given thickness of plate a decrease in the diameter of the rivet requires a decrease in the pitch, if the joint is to be kept as efficient as possible, and a decrease in the diameter of the rivet permits a decrease in the width of the margin—in fact, it may *require* a decrease in the width of the margin to make it possible to calk the joint permanently.

"Now, in fire-boxes a large margin is apt to become burned; therefore, in order to keep the margin and the overlap small, it will be necessary to adopt small rivets and a pitch much smaller than the greatest pitch which can be used and still have a tight joint with plate of the thickness used.

"If a joint is made between plates of different thicknesses, the dimensions of the joint and its efficiency should be calculated for the thinner plate."

The last 24 pages of the report are devoted to a mathematical analysis of the strength of various types of riveted joints. The method pursued is to take a joint of given dimensions and ascertain the percentage of strength that it bears to the full plate, and then so modify those dimensions that a higher percentage will be obtained. As the first example, where two $\frac{9}{16}$ in. plates are brought together with a lap-joint, with a single row of $1\frac{1}{16}$ in. rivets spaced $2\frac{1}{4}$ in. from centre to centre, it is found that the least resistance is that opposed to shearing, but that this is only 41.4 per cent. of the strength of the full plate. But "if the size of the rivet remain unchanged, the efficiency can be increased by making the pitch smaller, and when the resistance to tearing along the net section equals the resistance to shearing the greatest efficiency that can be obtained by changing the pitch has been reached."

This same method is carried through a large number of joints, the analysis naturally increasing in length and elaborateness with the increasing complexity in the design of the joint. Without following this work out in all of its details, we give the Committee's summary of the efficiency of a number of joints that are now in actual service, the engravings of which are here reproduced.

Sketch Number.	Efficiencies.
9 and 10	80.5 per cent.
21	77.7 "
22	86.6 "
23	77.3 "
24	84.6 "
26	90.4 "
27	82. "

In discussing the report on the Wear of Driving-wheel Tires, Mr. McConnell said :

"In order to determine what effect high speed, increased weight, and increased boiler pressure had on the wear of the tire, I have inspected some of our locomotives covering a period of 20 years. I started in with five 16-in. cylinder, 69-in. driving-wheel, carrying 140 lbs. pressure, time-card speed of 22 miles an hour. After they were worn out they were rebuilt with 17-in. cylinder, 150 lbs. of steam, and increased speed to 25 miles. We afterward built them 18-in. cylinder, 160 lbs. pressure and increased speed to 33 miles. We have some engines now with 180 lbs. of steam, time-card speed, 41 miles. The 16-in. cylinder, with 140 lbs. pressure had about 28,000 lbs. weight on the driving-wheel, and the average wear of the tire on this engine was 14,722 miles per $\frac{1}{16}$ in. of wear ; with the engine rebuilt, steam pressure increased to 150 lbs., speed 25 miles, tire wear decreased to 11,092 miles per $\frac{1}{16}$; with the 18-in. cylinder, carrying about 73,000 lbs. weight on the driving-wheel, 160 lbs. of steam, 10,320 miles per $\frac{1}{16}$. These same engines, when we increased the speed to 33 miles, and 180 lbs. pressure, we got 3928 miles to $\frac{1}{16}$; with the engines on the fast mail, the time card speed 41 miles weighing 107,000 lbs., and 69,000 lbs. weight on the driving-wheel, 180 lbs. pressure, the average mileage was 6717 per $\frac{1}{16}$. That shows the effect of high speed, high steam pressure and increased weight on the driving-wheel. There was a variety of tires—Nashua, Union Steel, Midvale, Krupp, and others ; the diameter of the driving-wheel was the same."

Before adjournment the annual election of officers was held, with the following result : President, R. C. Blackall ; First Vice-President, R. H. Soule ; Second Vice-President, Pulaski Leeds ; Secretary, Angus Sinclair ; Treasurer, O. Stewart.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

Chemistry Applied to Railroads.

SECOND SERIES.—CHEMICAL METHODS.

XVI.—METHOD OF TAKING COLD TEST AND CHILLING POINT OF OILS AND OTHER LIQUIDS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

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(*Continued from page 257.*)

OPERATION.

For cold test, put about 1 oz. of the liquid to be tested into a common 4 oz. sample bottle, and place a short stout thermometer in it. Then place the bottle in a situation where the liquid will become frozen, using for this purpose a freezing mixture if necessary. When the liquid has become solid throughout, remove from the cold and allow the liquid to soften, thoroughly stirring and mixing it at the same time, by means of the thermometer, until the mass will run from one end of the bottle to the other. Now grasp the bottle by the neck, having in the same hand a little waste or a towel, which encloses the thermometer, withdraw the thermometer through the waste, to wipe it far enough to see the mercury, and read the temperature. The reading is the cold test of the liquid.

For chilling point, where it is desired to know whether the liquid remains clear at any given temperature. Use the same bottle, amount of liquid, and thermometer as for cold test. Expose the liquid to the given temperature, or a little below, stir it with the thermometer occasionally, until the temperature of the whole liquid becomes that desired, then allow to stand for the time specified, at the end of which observe whether the liquid remains transparent and free from flocks or scales of congealed constituents. If so, it stands test.

For chilling point, where it is desired to know at what temperature flocks or scales of congealed constituents or more or less opacity takes place. Use bottle, amount of liquid, and thermometer as before. Expose to a temperature 5° colder than that at which the liquid is perfectly clear and free from flocks or scales, and allow the temperature to fall to that of the source of cold, with constant watching and occasional stirring. Lower the source of cold 5° more and treat as before. Proceed in this way until opacity or flocks or scales begin to show. The reading of the thermometer when this is the case is the temperature sought.

APPARATUS AND REAGENTS.

The 4 oz. sample bottles are readily obtained in the market. The round form is preferable. They are about 1¼ in. in diameter, and about 6¼ in. long over all.

The thermometer best adapted to cold tests are chemical thermometers with graduation engraved on the glass tube and white enamel background behind the mercury column. Since they are used as a stirring rod during the operation, in a moderately viscous liquid, they should be made of strong tubing. Of course the graduation should embrace the range of the cold tests to be taken. Graduation finer than single degrees is not necessary. For taking chilling points special thermometers may be obtained in the market, which are so made that the mercury column, even at quite low temperatures, projects above the bottle, so as to be easier read. The same thermometers may of course be used in taking cold tests, provided they are strong enough and long enough.

Quite a number of methods have been proposed for obtaining the cold to be used in taking cold tests and chilling points. None, however, are apparently so simple, easily manipulated, and expeditious as freezing mixtures. Three cases are to be considered.

1. *For cold test.* If the cold test is above 35° F. use a mixture of snow or pounded ice and water in any suitable non-conducting vessel. Quite a good sized-vessel and a plentiful supply of snow or pounded ice works best. The bottle with oil and thermometer is plunged into the liquid and allowed to remain until the liquid is frozen solid. For cold tests from 35° F. down to zero, use a mixture of two parts by weight of snow or pounded ice and one part of common salt. The same remarks as above in regard to vessel, plentiful supply and manipulation apply. For cold test from zero F. to 30° below use a mixture of three parts by weight of crystallized calcium chloride and two parts of snow or very finely pounded ice. The crystallized calcium chloride, if obtained in the market, should be crushed in a mortar to pieces not larger than wheat kernels. For cold tests approaching the lower range of the above limit, the vessel should be non-conducting and should be cooled to 32° F. before putting in the calcium chloride and ice. The crystallized calcium chloride may be bought in the market, but the following method gives a very cheap and efficient article from materials always at hand in every good laboratory—viz.: Put about a pound of pulverized carbonate of lime—marble dust works best—into a casserole holding three pints or two quarts, and pour concentrated commercial hydrochloric acid on it, little at a time. A neutral solution of calcium chloride is formed very quickly, after each addition of acid, and in a short time the mass becomes wet enough to be stirred to facilitate the action. Proceed with the addition of the acid until nearly all the marble dust is dissolved, taking care to avoid an excess of acid. Pouring the acid on to the marble dust, instead of adding the dust to the acid, avoids the suffocating fumes of HCl, which are sure to be given off if the latter procedure is followed. After the last addition of acid filter into any convenient metal vessel whose weight is known, then boil until a drop of the liquid put on a watch glass, and cooled by placing the glass on a lump of ice, becomes solid moderately quickly, then cool by placing the vessel in another vessel containing ice and water. As the temperature falls, the calcium chloride should be stirred to prevent the formation of a compact mass not easy to break up. If the operation is properly performed, when the temperature of the calcium chloride reaches 40° F. or a little below, the material in the metal vessel will be a more or less mushy mass of crystals of calcium chloride. Remove now the metal vessel from the ice-water, wipe it dry on the outside, and weigh to determine the amount of calcium chloride. Wrap the bottom and sides of this vessel well with towels or other non-conducting material, and then for every three parts of calcium chloride add two parts of snow or finely pounded ice, and stir thoroughly. After a minute or two the material to be tested can be placed in the liquid, and the whole thing should then be covered to prevent access of heat.

2. *For chilling point*, when it is desired to know whether a liquid remains clear at any given temperature. Temperatures

from any one at which the liquid to be tested is clear down to 32° F. are easily obtained. Put a gallon of water in a bucket made of wood or indurated fibre, and add warm or colder water or ice, as the case may require, until the desired temperature is obtained, then add the bottles of liquid to be tested, taking care to keep the water the required temperature during the cooling of the liquids in the bottles by the proper additions. Temperatures from 32° down to zero F. may also be easily obtained. To a gallon of water in a bucket of wood or indurated fibre add, 15 lbs. of cracked ice. Stir thoroughly with a wooden stick, and when the temperature has reached 32° F. or thereabouts, add, with continued stirring, dry common salt, sufficient to produce the temperature desired. Approximately each quarter pound of salt added will lower the temperature under the conditions given above 2° F., until about 10° is reached, when twice the quantity must be added to bring the temperature down 2°. As the usual specified temperatures at which chilling points are observed are 32°, 20°, 10°, and zero F., it is fairly safe to say that these temperatures may be obtained as follows :—32° F.: into a wooden or indurated fibre bucket put 1 gall. of water, and any convenient amount of ice, provided only sufficient is used. 20° F.: 1 gall. of water, 15 lbs. of cracked ice, and 1½ lbs. of dry common salt. 10° F.: 1 gall. of water, 15 lbs. of cracked ice, and 3 lbs. of dry common salt. Zero F.: ½ gall. of water, 15 lbs. of cracked ice, and 5 lbs. of dry common salt. A little experience will enable the temperatures desired to be reasonably well controlled. Of course the melting of the ice continually dilutes the salt solution, and if fairly constant temperature for some time is desired, occasional small additions of salt will be needed. For temperatures below zero F., crystallized calcium chloride may be used in place of common salt. So much depends on the amounts of the materials used, and especially when dealing with such low temperatures, on the appliances, and the protection given to the vessels in which the cold is produced, that it is perhaps hardly wise to try to give proportions. It may be said, however, that 3 lbs. of finely crushed ice, and 2 lbs. of crystallized calcium chloride in a properly cooled and protected vessel, will give 10° below zero F., and 3 lbs. of finely crushed ice, and 3¼ of crystallized calcium chloride under the same conditions, will give 20° below zero F. A few experiments are worth more than a good many directions, and the principles involved seem perfectly clear.

3. *For chilling point*, when it is desired to know at what temperature flocks or scales of congealed constituents of more or less opacity takes place. Use the way of obtaining the desired temperatures described in the preceding paragraph, except that in going down the scale temperatures 5° apart are produced by the proper mixtures, and used as described under "operations."

CALCULATIONS.

The figures involved in this method are simply readings of thermometers, no calculations being necessary.

NOTES AND PRECAUTIONS.

It will be observed that this method, so far as cold test is concerned, consists practically in freezing the liquid to be tested, and then taking the temperature of the thawing, mushy mass, when it will just flow from one end of the bottle to the other. It is quite well known that other characteristics of the cooling of liquids have been made use of as cold test, also other methods of manipulation have been prescribed. For example, the temperature at which flocks of congealed constituents begin to separate has been called the cold test of a liquid ; or, in other words, the liquid has been said to stand cold test if it remained perfectly clear at any given temperature. Still further the cold test of a liquid was formerly taken by putting an ounce or so in a bottle, as described above, hanging a thermometer in the centre of it, and then exposing the whole thing to cold without agitation, and observing the temperature at which the last part of the liquid or that immediately surrounding the thermometer became congealed. In view of this diversity of practice the distinctions given in the earlier part of this method seem desirable.

It is well known that most liquids whose cold test is desired contain constituents which congeal at different temperatures ; in other words, they are not homogeneous. It is also well known that when liquids made up of constituents which congeal at different temperatures are exposed to the slow action of cold, the constituents of highest congealing point solidify first, next to the sides of the bottle, provided the liquid is left undisturbed, and a little later, if the source of cold is low enough, constituents of lower congealing point solidify, and so on gradually forcing to the centre of the bottle those constituents which have the lowest congealing point. Furthermore, it is well known that the separation of constituents of different congealing points, as described above, is affected by the rate at which the cold penetrates the mass of liquid. If the rate is very slow, that portion of the liquid around the thermometer which congeals last will show a much lower figure for cold test than if the rate of cooling is more rapid. In view of these facts, it is evident that the method formerly in use—viz., observing the temperature at which that part of the liquid around the thermometer, as above described, congealed—did not give the cold test of the whole liquid, but of that constituent which congealed at the lowest temperature, and that the figure obtained was a function of the rate of cooling. It is believed that the method described above obviates these difficulties, and that with some experience and sufficient care in the manipulation, duplicate results can be obtained on the same sample, which will agree within 2° or 3°.

It will be noted that the directions require stirring and mixing of the liquid, both in taking cold test and chilling points. The object of this is to enable the cold test or chilling point of the whole liquid to be obtained, rather than that of constituents of it, as explained above. Moreover, without stirring and mixing, the whole mass would not be of the same temperature, since the thawing or access of heat in taking cold test proceeds from the outside toward the centre. It is, of course, recognized that the chilling point is affected by the agitation of the liquid during cooling ; in other words, it is probable flocks or scales separate at a little higher temperature with agitation of the liquid than if it is allowed to remain perfectly quiet. No practical method of getting the whole of the liquid cooled to the same temperature within reasonable time is known, however, except to stir and mix, and since the manipulation is prescribed, no unfairness results. It may be queried whether the amount of stirring does not have an influence, but experiments seem to indicate that if a liquid is close to the margin, any stirring will be sufficient to cause flocks or scales to separate, while if the limit is somewhat wide, considerable stirring will not bring turbidity.

With proper appliances a very large number of cold tests can be made in a day. Also chilling points to see if the liquid remains clear at any specified temperature, require no very elaborate manipulation. Chilling points to see at what temperature turbidity begins are much slower, since they require constant watching and manipulation.

PERSONALS.

MR. W. J. MCLEAN has been appointed District Passenger Agent of the Mobile & Ohio Railroad, with headquarters at Chicago, Ill.

MR. W. H. HARRISON has been appointed District Passenger Agent of the Mobile & Ohio Railroad, with headquarters at No. 220 Fourth Street, Des Moines, Ia.

MR. M. H. BOHREER has been appointed District Passenger Agent of the Mobile & Ohio Railroad Company, with headquarters at No. 168 Griswold Street, Detroit, Mich.

MR. W. E. WILLIAMS has been appointed Purchasing Agent and Storekeeper of the International & Great Northern Railroad Company. He will have immediate charge of all purchases and distribution of supplies, with headquarters at Palestine, Tex.

PROCEEDINGS OF SOCIETIES.

Engineers' Club of St. Louis.—At the meeting of June 5 Mr. Bryan stated that a meeting of the local membership of the American Society of Mechanical Engineers had been held, the unanimous sentiment of which was, that arrangements be made to invite the Association to hold its spring meeting of 1896 in St. Louis, and it was thought that the movement would be strengthened by being endorsed by the Engineers' Club of St. Louis. On motion of Mr. Moore, it was ordered that the Executive Committee extend, on behalf of the Engineers' Club of St Louis, an invitation to the American Society of Mechanical Engineers to hold their spring meeting of 1896 in St. Louis.

American Society of Mechanical Engineers.—The spring meeting of the Society was held at Detroit, Mich., from June 25–28 inclusive, with headquarters at the Russell House. The following professional papers were presented : The Old and the New, by Robert Allison ; A New Form of Sterilizer, by A. M. Goodale ; A Portable Disinfecting Plant, by W. H. Francis ; The Strength of Iron as Affected by Tensile Stress

while Hot, by De Volson Wood; The Effect of Length of Specimen on the Percentage of Ductility, by R. C. Carpenter; A T-Square and its Mountings, by W. A. Gabriel; Efficiency of Boilers, by F. W. Dean; Force Required and Work Performed in Driving and Pulling Out Wire Nails, by R. C. Carpenter; New Forms of Friction Brakes, by W. F. M. Goss; A H.P. Planimetre, by E. T. Willis; A Coal Calorimetre, by R. C. Carpenter; Tests to Show the Distribution of Moisture in Steam when Flowing in a Horizontal Pipe, by D. S. Jacobus; Analysis of the Tremont Turbine, by DeVolson Wood; Rustless Coatings for Iron and Steel (third paper), by Matthew P. Wood; A Piece-Rate System, by F. W. Taylor; The Down Draught Furnace for Steam Boilers, by William H. Bryan; A New Shaft Governor, by E. T. Armstrong; A Method of Proportioning the Cylinders of Compound Engines, by E. C. Knapp; Expansion Bearings for Bridge Superstructures, by George S. Morison; Tests of the Experimental Engine of Sibley College, Cornell University, by R. C. Carpenter; Tests of a Combined Electric Light and Electric Railway Station, by D. C. Jackson; Pipe-Covering Tests, by George M. Brill.

THE PENBERTHY GREASE-CUP.

With the reports of professional committees at the Wednesday morning session there was presented and discussed two papers by Mr. W. J. Keep, of Detroit, Mich., member of the Society, contributed as monographs upon subjects forming part of the work of the committee of the Society upon Standard Methods of Tests and Testing Materials. One is entitled Transverse Strength of Cast Iron, and the other is entitled Keep's Cooling Curves, and the Molecular Changes in Metals due to Varying Temperatures. The social features of the meeting consisted of an excursion to Belle Isle Park and a drive around the same, a lunch on the roof garden of the new Chamber of Commerce Building, a full-dress reception at the Detroit Club, and a trip to Lake St. Clair and the St. Clair River, with a fish supper at the St. Clair Flats.

Manufactures.

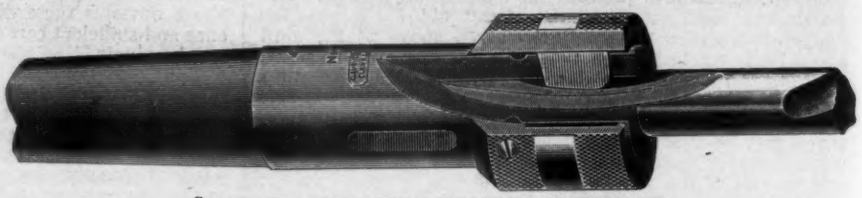
PENBERTHY GREASE-CUP.

THE peculiarity of this new grease cup, which has recently been brought out by the Penberthy Injector Company, of Detroit, Mich., is, first, that the body consists of a glass cylinder surrounded and protected by an outer brass shell with openings on four sides, through which the user can see at a glance the amount of grease or "dope" in the cup, and know when to refill it, so that the journal where it is used never need be dry unless through carelessness. The plunger by which the grease is forced out from the bottom of the cup is made of a heavy rubber washer, protected on both sides by a brass disk, the whole being attached to the bottom of the stem in such a manner that the stem revolves without turning the washer or disks, and at the same time no grease can pass up through the centre of the washer. The cover never needs to be removed from the cup, as the body of the cup is screwed on to the shank and is removed from the shank to be refilled; therefore there is no chance for any of the parts to be lost or mislaid when the cup is being filled. This cup has met with much favor when it has been used, and the makers report large orders received, although it has been in the market but a short time.

DRILL GRIP-SOCKET.

THIS grip-socket is designed to hold and drive taper shank drills and other tools. A groove which is an arc of a true circle is milled in the shank of the drill or tool, as shown in the sectional illustration, a key let into the body of the socket fits into the groove, and is locked securely in place by a turn of the revolving internally eccentrically counter-bored collar.

After the key is locked it is impossible for the tool to slip in the socket or to be pulled out until the collar is turned back again to release the key. The end of the collar is bevelled, and a plain index mark on it and on the body of the socket shows when the key is released.



SECTION CUT AWAY TO SHOW GRIP OF KEY ON THE SHANK.

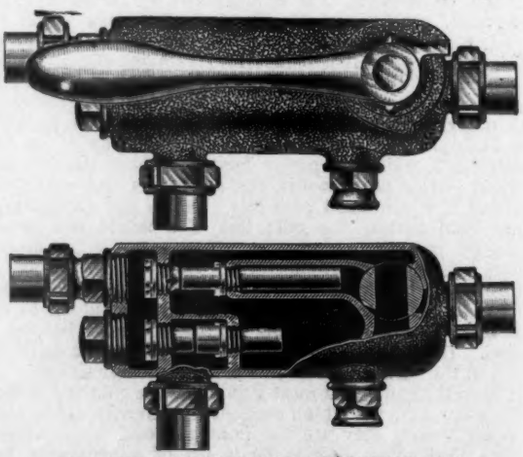
SOCKETS AS TURNED OUT BY THE FACTORY READY FOR USE.

DRILL GRIP-SOCKET.

Drills or tools that have had the tangs on the shanks twisted off can be used in these grip sockets successfully, and in this way the cost of the sockets can be saved many times annually. Boring bars for under cutting can be used without any danger of their pulling out of the sockets, and the labor and expense of turning over heavy pieces saved.

THE BROWNLEY DOUBLE-TUBE INJECTOR.

THE engravings given herewith show the external appearance and the section of the Brownley double-tube injector that has recently been placed upon the market by E. F. Keating, of 455 Water Street, New York. The peculiarity of this injector is that it is double-tubed and valveless, and that it will work under any steam pressure ranging from 15 lbs. to 350 lbs. per square inch, and this, too, without any regulation and without breaking. It is also claimed that it will lift the feed-water 3 ft. when the temperature is 156° F., and that it will raise it 22 ft. when the temperature is 130°.



THE BROWNLEY DOUBLE-TUBE INJECTOR.

As will be seen from an examination of the engravings the device is a very simple one. The steam inlet is one size

smaller than the suction or the delivery, which is said to give very economical results in the consumption of steam. For starting the injector it is merely necessary to open the steam cock, when water will appear at the overflow; the cock is then turned by means of the lever shown, when the water will be fed into the boiler. No variation of steam pressure at any point from 350 lbs. down to 6 lbs. will cause any loss of water at the overflow. A test has been made in which the foreman of the Manhattan Elevated Railroad found that the Brownley would throw about 33 per cent. more water than the standard injector. The simplicity is such that the makers assert that any mechanic can take one apart and put it together in five minutes.

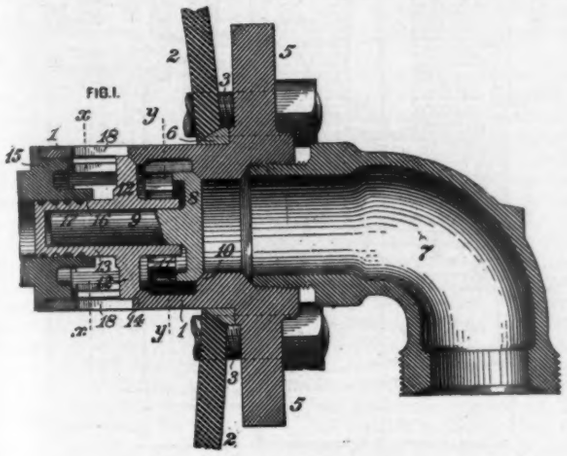
The injector for locomotive purposes is slightly varied from the ordinary one in form, so that it can be put on where others have been previously used, and is so constructed that no jarring or shaking to which it may be subjected while running will cause it to break.

Recent Patents.

CHECK-VALVE.

TAYLOR W. HEINTZELMAN, of Sacramento, Cal., has patented the two forms of check-valves shown by figs. 1 and 2. It will be seen that in each case there is a valve inside of the boiler which will close and prevent the escape of hot water

FIG. 1.



HEINTZELMAN'S CHECK-VALVE.

and steam in case the valve is knocked off by accident. The construction of these valves will be apparent from the engravings without description. The patents are numbered 537,038 and 538,831, and are dated April 9 and May 7 respectively.

STEAM SEPARATOR.

An inventor with the aliterative name of Jules John Joseph De Rycke, of Brooklyn, N. Y., has patented the arrangement shown by fig. 3. This represents a section of an ordinary locomotive dome and steam space over the fire-box. *D* is the throttle-valve of the ordinary construction, *B* the dry-pipe, which projects upward inside of an enlarged vertical pipe, *C*, and which has an annular space, *C'*, between the two. *E* is a deflector with conical wings, and which is held in a fixed position by the shaft E^2 and a stop, *c*. C^2 is an extension of *C*, which communicates with the annular space C^1 and C^4, a valve which is opened and closed by the bell-crank *F*, rod *H*, and throttle-stem *G*, which is operated by a throttle-lever of the usual kind. C^5 is a check-valve attached to the end of the pipe C^2 to prevent water and steam from flowing into C^2, but which opens whenever the pressure in the annular space C^1 exceeds that in the steam space above the surface of the water.

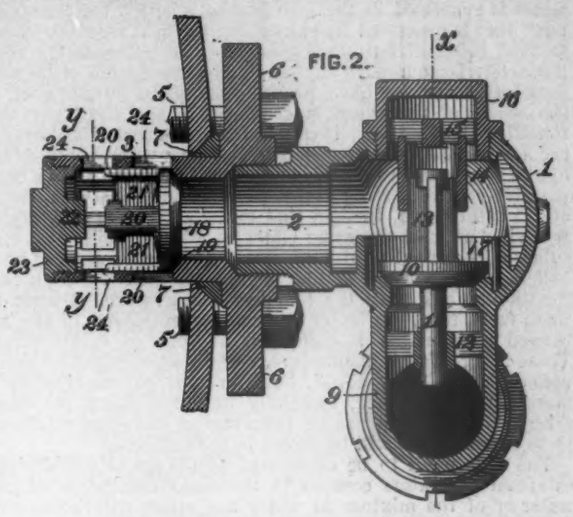
The operation is as follows: The steam enters the dry-pipe through the throttle in the usual way. In passing downward in the pipe *C* it encounters the helical wings E^1, which gives the steam a rotary movement, and the centrifugal force carries the heavier particles of water outward, so that they are brought in contact with the inner surface of *C*, and then pass downward and are drained off through the pipe C^2.

The patent is dated May 28, and is number 539,859.

COMBINED TUBULAR BOILER AND SUPERHEATER.

In the AMERICAN ENGINEER for February of this year (p. 89) a description was given of Schmidt's boiler, and of some remarkable results which were attained in tests made

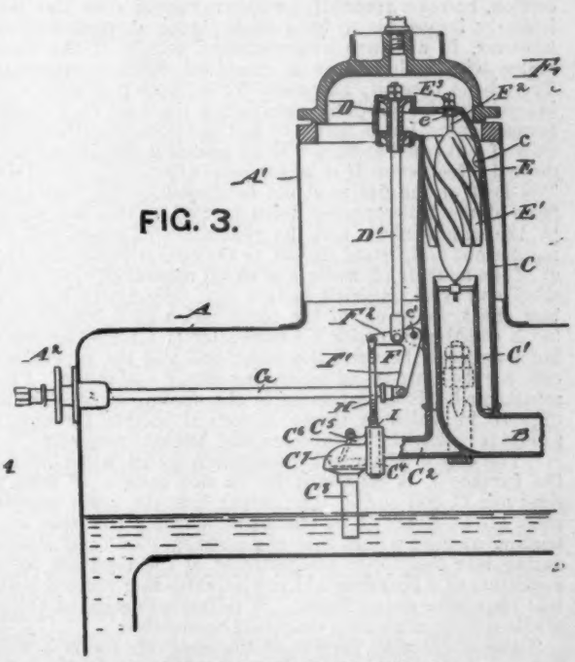
FIG. 2.



HEINTZELMAN'S CHECK-VALVE.

with it in Germany. In our issue for April, p. 192, extracts from a patent taken out by him were published. Another patent has just been issued to him, in which he describes

FIG. 3.



DE RYCKE'S STEAM SEPARATOR.

some improvements in his invention. Notwithstanding the length of this description, our readers, we think, will be repaid for reading it carefully:

"Before entering into the details of the mode of construction of my improved combination shown in the drawing (fig. 4), I think it necessary to give some preliminary statements and explanations, in order to render the idea of the invention perfectly clear and intelligible.

"If steam is to be superheated to a temperature of about 300°, the heating gases should have, as is well known, a temperature of at least from 500° to 600°. The said former temperature will be reached best by arranging the superheater above the steam generator, and exposing it to the furnace gases of the same; or, in other words, by arranging the superheater behind the steam generator with regard to the direction of the furnace gases of the latter, and exposing it to a zone of

said gases, in which the temperature amounts to about 600°. The fire gases need thus be cooled down by the boiler proper but to about 600°, while generally, in a steam generator without superheater an exhaust of the heat down to 250° is required. As is well known, however, the greatest part of steam is generated in the fore part of a boiler, the remaining part, that is generated by exhausting the heat from 600° down to 250°, being of but small quantity, and necessitating comparatively large heating surfaces. Extended trials made with locomotive engines have proved that about 50 per cent. of the whole of the steam is generated in the small part surrounding the fire-box. It results from this that when arranging a superheater for temperatures of about 300° above or behind a steam generator, the latter not only may have a comparatively small heating surface, but should have such a one; and it will be seen, further, that such boiler with superheater will yield at least the same effect as a larger boiler that consumes a like quantity of fuel, since the furnace gases of both boilers are exhausted in like degree—*i.e.*, are escaping into the smoke-stack with the like low temperature. Owing to these facts, now, the boiler or generator employed in my improved combination is composed of coils or coiled pipes. These latter offer, in themselves, certain advantages for every boiler plant. They could, however, not be employed in a more extensive degree, especially for large plants, as there arise in the practical use of them serious drawbacks difficult to be overcome, as will be shown in the following.

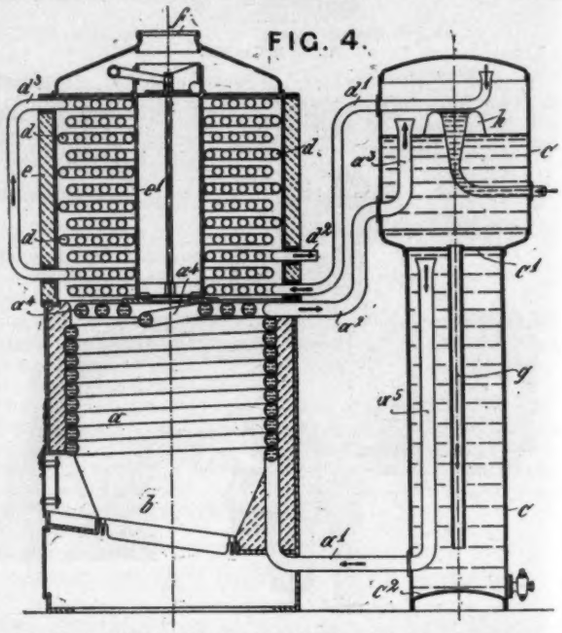
The main point to be considered in the use of coiled pipes as steam generators consists in the rapid circulation of the water or of the mixture of water and steam within the coil. Such circulation is indispensably requisite. The same is considerably hindered or delayed, however, by the great friction arising between the water and the inner walls of the pipes, especially if the latter are of a somewhat great length and of but small inner section. This disadvantage could be overcome, seemingly, by using pipes with larger section. This section, however, necessitates dimensions of such size that it is nearly impossible to bend such pipes. A perfect change, however, in all these circumstances occurs, if the tubular boiler with coiled pipes is combined with a superheater. There is no necessity any more for providing so large a heating surface for properly exhausting the heat of the fire or furnace gases, but a boiler of but the fifth or sixth size with coils of but small section will be sufficient for delivering the desired effect, even if a larger number of H Ps. is required. The heat of the fire need not be cooled by the heating surfaces of the boiler proper down to 250°, as this is performed by the superheater; and the generation of steam will be a regular one and free of shocks, as the circulation of the water, or of the mixture of water and steam respectively, within the short coil with its small section is a very active one. The best effect, however, of the combination of a tubular boiler (with coiled pipes) with a superheater is attained by arranging a reservoir between the boiler coil and the superheating coil, for the purpose of separating water and steam. I have represented this arrangement in the accompanying drawings (fig. 4), in which is shown a vertical section through the tubulous boiler, the superheater, and the said reservoir.

"The coil *a* of the tubulous boiler, which is heated from the furnace *b*, is connected by its two ends a' a^2 with the reservoir *C*, coil end a' terminating into the lower compartment of the reservoir by the mediation of a bent tube a^5 extending upward within said compartment; coil end a^2 terminating into the upper compartment of the reservoir by the mediation of a bent tube a^3 likewise extending upward within that respective compartment. The further details of the reservoir will be more fully described hereinafter.

"The uppermost portion of the reservoir forms a steam dome, and the saturated steam is led from that dome by the mediation of pipe d' into the superheating coil *d*, from which the superheated steam is led away by pipe d^2. The feedwater for the boiler, or for coil *a* respectively, enters the latter through the pipes a^5 a', and leaves the coil, after being heated and partly turned into steam within the same, by the pipes a^2 a^3. The mixture of water and steam separates within the upper compartment of the reservoir *C*, the steam collecting within the dome, the boiling water mixing with the feedwater and heating the same.

"The superheater consists of a number of superposed flat horizontal coils, which are connected with each other to a continuous passage. This connection of the coils, however, is made in such a way that two divisions are formed out of them; the first division, next to the boiler-coil, being passed by the steam in a direction like that of the furnace gases; the other division being passed by the steam in the opposite direction—that is to say, opposite to the direction of the furnace gases. Both divisions are connected by the bent tube d^3. The said superheating coils are arranged in the annular space between the outer wall *e* and the inner wall e'. The furnace gases coming from the fireplace *b* are led through the said space, and leave the whole apparatus at *f*. It will be seen now that the circulation of the water, or of the mixture of water and steam respectively, within the boiler coil will be a very intense one, as, first, the said coil is but short, and has but a small section; and as, second, the contents of coil *a* are constantly under the pressure of the water column within the lower compartment of reservoir *C*. The generation of steam is, therefore, a very intense and rapid one, as well as free of shocks, and the steam then enters the superheating coils without the least addition of water, as the latter is perfectly kept back by the reservoir. The water now circulates again and again through the boiler coil, so that the whole of the water within reservoir *C* is heated to a high degree of temperature. This circulation will, as a matter of course, be the more active the greater the difference in pressure between the water column within the lower compartment of the reservoir, and the water and steam column within the boiler coil; and, further, the less the resistance offered by the friction

FIG. 4.



SCHMIDT'S COMBINED TUBULAR BOILER AND SEPARATOR.

between the said water and steam column and the inner walls of the boiler coil. It results herefrom that the whole of the water contained within, or entering, the said boiler coil cannot be turned into steam at so rapid a circulation, and it becomes thus necessary to provide the reservoir *C* for separating both parts of the water and steam mixture leaving the boiler coil, as but the steam can be permitted to enter the superheating coil, while the hot water must remain.

"Concerning now the special construction of the reservoir, the latter is divided into two superposed compartments by a horizontal plate *C'* having secured to it a vertical tube *g* extending downward to the neighborhood of the bottom C^2. The vertical tube a^5 communicating with end a' of the boiler coil is arranged in the same compartment of the reservoir, and extends upward to the neighborhood of plate *C'* aforementioned. The purpose of this arrangement is to separate and precipitate sediments and the like contained in the feedwater, for preventing the boiler coil from becoming incrustated. The feedwater enters the upper part of the reservoir through the funnel *h*, and the sediments separated by the heating of the water flow, together with the latter, down into the under compartment of the reservoir through tube *g*. The water, then, in order to enter the opening of tube a^5 flows upward again, while the sediments remain back and precipitate on the bottom C^2.

"The uppermost part of the vertical boiler coil *a*, or that part situated between the coil *a* proper and the pipe a^2, is formed to a horizontal coil a^4, the purpose of which is to break the intense heat discharged by the fire, so that the superheater is prevented thereby from becoming pervious."

Mr. Wilhelm Schmidt, of Wilhelmshöhe, Germany, is the inventor, and his patent is dated May 28, 1895, and numbered 539,827.

AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of THE AMERICAN ENGINEER.

THE PROPOSED FRENCH CAPTIVE BALLOON.

IN the catalogue and price list of balloons and aeronautical materials, recently issued by Messrs. Louis Godard, Ed. Surcouf & J. Courty, aeronautical engineers and successors of the late Gabriel Yon, we find further data concerning the giant captive balloon which these gentlemen propose to build for the French International Exposition of 1900.

It is proposed to make this 144 ft. in diameter, to hold 1,600,000 cub. ft. of hydrogen gas, and to lift 160 passengers at once. It is to be equipped so as to permit ascensions to a height of 3,280 ft.

It will be remembered that the largest captive balloon hitherto built, that of Giffard in 1878, was 118 ft. in diameter, contained 860,000 cub. ft. of gas, and was equipped to rise to 1,500 ft. The new balloon, therefore, will have so much greater lifting power as to admit of strengthening all the parts to a much higher factor of safety, so as to make it safe against the highest winds. It is estimated that it can be operated at least nine days out of ten, even during windy weather.

The balloon skin is to be composed of four thicknesses of a special silk tissue, with a coefficient of resistance, both in the direction of the warp and the woof, of 1,200 kilograms per lineal metre (805 lbs. per lineal foot), united together by a special varnish which increases the resistance, so that the combined skin will exhibit a strength of 5,000 kilograms per lineal metre, or 3,353 lbs. per lineal foot. It is calculated that in a wind of 45 miles per hour the external pressure on the balloon can be compensated by an internal pressure equivalent to eight-tenths of an inch of water, and that the skin will then be strained to only one-twenty-third part of its ultimate resistance.

This calculation, however, is based upon the assumption that the resistance of a sphere is 20 per cent. of that of a plane equal in area to its mid-circle, while we know of some experiments which show twice this coefficient.

In order to maintain the internal pressure requisite to compensate for the wind, for variations of temperature or for the height attained, without loss of gas, an internal bag or air balloon, of one-seventh of the total cube, is kept more or less inflated with air pressure, so as to compress more or less the gas in the balloon, and thus keep the skin uniformly distended and to preserve the spherical shape at all times. The air balloon is to be provided with an automatic valve set to open at a pressure slightly less than the hydrogen gas valve of the main balloon, and thus, whenever the internal pressure increases from any cause, air runs to waste instead of gas.

The netting is to be made of hemp dipped in a preparation of india rubber, and the points of junction of each mesh are to be shielded with a light strip of leather to prevent abrasion of the balloon skin. There are to be 384 meshes at the circumference, and 768 lines forming the net, with a breaking strength of 1,200 kilograms each, whence it is calculated that the total resistance is equal to 900,000 kilograms, or 1,980,000 lbs. against a vertical pull. This netting is concentrated by means of *pattes d'oies*, or reducing meshes, into 48 suspension cords, which attach to the main circle, from which the car is suspended, with the intervention of a dynamometer.

The main cable is to be of extra selected hemp, and to measure 5 in. in diameter at the balloon and 4 in. in diameter at the ground, this tapering shape being adopted to insure that rupture, should it occur at all, shall occur near the ground, so as to avoid the danger from a cable falling from overhead, and to have the balloon loaded with a long guide rope in the improbable contingency that it should get away. The strength of the cable is calculated at 90,000 kilograms (198,000 lbs.) at the top, and 60,000 kilograms (132,000 lbs.) at the bottom.

The car is to be annular in shape, with an exterior diameter of 33 ft., and an internal diameter of about 20 ft., thus forming a circular gallery 6½ ft. wide, capable of accommodating 160 passengers. The floor area is to be 540 sq. ft., and under this are placed various receptacles for the tools and supplies. The ballast is to be stored under a circular bench, on which the passengers are to sit.

As already intimated, a dynamometer intervenes between the suspension cords and the main cable. This enables the aeronaut to know at all times what the lifting power is, and to regulate the vertical traction of the balloon upon its cable with regard to the wind, so that the corresponding angle shall not exceed 45°.

The main cable passes from the dynamometer under a main pulley attached by a universal joint to a strong frame of wrought and cast iron, and is thence led to a drum upon which it is wound by a double steam engine of 600 H.P. This consists of four cylinders, coupled in pairs, with cranks at right angles with each other, and the speed is to be such as to admit of three ascensions and returns per hour. When ascending, the balloon serves as a motor and operates upon the cylinders, which are provided with air pipes so as to serve as regulating brakes by acting as air pumps. There is to be, moreover, an automatic safety brake operated by air.

The total cost of the plant is estimated at $200,000, and it is expected to be able to operate for 160 days out of the 200 that the Exposition is to last. The receipts during that period are estimated at $800,000, from which should be deducted the operating expenses, but probably leaving a profit besides paying for the plant.

The scheme seems to have been devised with great care to ensure safety, and with the experience that the public of France has hitherto had of the small danger incurred in such ascents, together with the magnificent views to be obtained from a balloon in the unsmoked air of Paris, it seems probable that the enterprise will prove a great success.

HIGH BALLOON ASCENSIONS.

IN AERONAUTICS for December, 1893, and again for March, 1894, there were given accounts of the high ascensions of the balloon *Aerophile* from Paris on March 27, 1893. In this JOURNAL for January, 1895, an account was published of the ascension of *Cirrus* from Berlin on July 7, 1894.

In the *Zeitschrift für Luftschiffahrt* for February and March of the current year there is a very interesting account of a triple balloon ascension from Berlin on September 6th, 1894. It is understood that all these records will shortly be published in book form, and that is the reason we have now only a short outline of the observations. Too much praise cannot be given for these attempts to explore the upper air, and we may hope that such exploration may become much more systematic, both abroad and in this country.

On September 6 the balloon *Cirrus*, 8,760 cub. ft. capacity, was inflated with coal gas and liberated at 8.45. Its course was east northeast, and it quickly disappeared from view. Nothing more was heard of it till the last days of September, when it was found in Russia, not far from Wilna. The principal figures that have been published will be found at the end.

Four minutes later the *Phœnix* (70,600 cub. ft.) was liberated, with Professor Berson and Assistant Becker on board. The highest point reached was at 1.30 P.M., about 20,190 ft. The temperature at starting was 59° F., and at the highest point it was −15° F. At the time of the lowest temperature that at the earth's surface was 65°, and this would give a diminution of 1° F. in 252 ft. A similar computation for *Cirrus* gives 1° in 409 ft. It is impossible to explain this apparent discrepancy, but I do not think it due to a vastly less diminution with height at the higher levels.

Very soon after the *Phœnix* was liberated the balloon *Majestic* (106,000 cub. ft.), with three men on board, was released. This balloon arose only 3,600 ft., and no observations are given. In the accompanying table I have grouped together some of the more interesting facts brought out in the three very high ascensions. The formula used for computing the height of a balloon is that of Professor Ferrel. It is quite a pity that every one making these computations and publishing heights uses a different formula. For example, in the recent *Cirrus* ascension Ferrel's formula gives 61,350 ft., Professor Berson gives 60,531 ft., and the Smithsonian formula gives 59,670 ft. There ought to be some common understanding about this matter. Professor Ferrel's formula is undoubtedly the most accurate up to his time, and I have tables computed from it up to 75,000 ft. As a matter of fact, we have no accurate knowledge of the reliability of the barometric formula

much above 10,000 or 15,000 ft. It would be of the greatest interest if a large astronomical telescope could be turned upon an ascending spherical balloon, and its diameter measured with a micrometer at frequent intervals. It is also proposed to take up a camera and photograph the earth at various points as we ascend. Mr. Jewell, of Baltimore, has suggested that for this purpose there must be used an universal level, so as to determine when the camera is exactly vertical. A few accurate checks upon the barometrically computed height of a balloon up to 25,000 or 30,000 ft. would be invaluable at the present time.

RECORDS BROUGHT BACK BY HIGH BALLOONS.

Name.	Date.	Place.	Capacity	Temperature. Sea Level.	Temperature. Highest Point.	Height.	Direction.	Distance.	Velocity of Temp. Diminution.
			cu. ft.	F.		Ft.		mi.	m. per hour. 1°in.
Aerophile.	Mar. 27, 1893.	Paris.	4,000.	63	[−104]	52,280	E.S.E	78	12 313
Cirrus.	July 7, 1894.	Berlin.	8,760.	63	[−86]	54,530	S.S.E	622	62 366
Cirrus.	Sept. 6, 1894.	Berlin.	8,760.	59	[−89]	61,350	E.N.E	560	83 409

In the last ascension the enormous velocity of 83 miles per hour is extremely interesting. This was at an height of about 59,000 ft. At about 15,000 ft. Professor Berson found a velocity of 38 miles per hour, and his whole trip of 7 hours 6 minutes gave an average velocity of 17 miles per hour from start to finish.

H. A. Hazen.

April 30, 1895.

LONGITUDINAL STABILITY IN AERIAL NAVIGATION.

To the Editor of The American Engineer and Railroad Journal:

Sir: It is scarcely possible to overrate the importance of automatically obtaining longitudinal stability in aeronautic experiments. We are seeking to substitute an inanimate machine for the living animal. When a man walks, he is continually poising himself on one leg, and he does not fall because he has become so well practised in the art that he keeps his balance automatically, without giving the subject a thought. If we were to attempt to make a mechanical man walk, he would immediately fall. The mechanical man would require a substitute for the brain of the living man, and the substitute must necessarily be mechanical. The bicyclist supplies another illustration of this fact. A mechanical bicyclist is an impossibility. As a man in walking keeps his balance from long practice, so the bird keeps its horizontal position by the constant use of the tail. The bird appears to do this with so much ease that an observer is apt to conclude that no mechanical action is necessary; but this is a mistake. Just as a man, while walking or on a bicycle, continually moves to the right or left to prevent his falling by means of prompt, instantaneous action, quite unconsciously, so the bird secures its horizontal position.

The object of my invention is to supply this prompt action by means of the inverted pendulum, so mounted that the slightest departure from the horizontal immediately applies an independent power to the correction of the angle of incidence. A very small motive power is required for operating the rotating shaft, and this small power is a mere trifle compared to the loss which is incurred when an aviator in motion deviates from the horizontal to any great extent.

I regret that in the description of my device for steering, inserted in your March number, the curved arrow was placed on the wrong shaft by mistake; it should have been attached to the shaft 8.

Yours truly,

Thomas Moy.

HIS FIRST PARACHUTE DROP.

The Philadelphia *Times* recently published the following account of how a person felt on jumping from a balloon for the first time. Most of our readers will probably agree with us in thinking that as a piece of imaginative reportorial writing it is tolerably good.

"The great balloon which was to bear me on my first journey up into the azure heights, and from which I was to make my maiden leap with a parachute, was tugging at its moorings upon the broad lawn. I confess that it was with some nervousness I took my seat in the little car beside Joseph Norcross, a skilled aeronaut, who had from dizzy heights made many and many a flight earthward through the air. With this same balloon he had during the past year safely made 67 ascensions, and had each time successfully descended with the parachute. So why should I fear?

"Norcross smilingly welcomed me, and as he gave the order to cast loose the line and the men on the ground released the great aerial traveller, I felt myself afloat in a little boat upon an ether sea. There was no sudden jolt or jar about it, so cleverly was the release effected. Putting my head over the side of the car, I looked below and was surprised, for apparently we were not ascending, but the great world, with all her glory of green and gold, was dropping from us away down into space. I looked in pleased amazement upon the wonderful panorama presented as the earth kept receding. Norcross smiled.

"Then I gazed upward at the great birdlike balloon soaring triumphantly on. Again I looked down, and the houses and barns seemed to crouch closer to the ground and the villages to cluster together. Streams and lakes at last looked like mere threads or blots of silver. Away in the north the range of mountains looked like an emerald wall, while that dark blur on the earth below was the thriving and populous county seat. We were far from the world. Suddenly we were in a cold, drizzly rain, and the earth was shut from view. I inquiringly looked at Norcross.

"'We have entered the clouds,' was his smiling explanation, 'and we are not yet a mile high.'

"In five minutes we emerged into beautiful sunshine. Beneath us lay a heavy bank of fog burnished by the ardent afternoon sunlight, but the earth for a time was not within sight. Suddenly, through a rift in the clouds, I caught a glimpse of it far, far below. So distant was it that only here and there could an object on its surface be discerned. Truly we were getting well up in the world. The thought at once attracted my serious attention to the balloon. Suppose it should spring a leak or collapse, what would be the fate of the daring sky travellers? Or, on the other hand, if the valve line failed to operate, would we go on upward forever? The thought disturbed me not a little. The aeronaut surmised what was passing in my mind, smiled genially, and said:

"'I have made a thousand ascensions unharmed. From what height would you like to leap?'

"'Make it about 1,000 ft.,' I replied, determinedly.

"'All right,' Norcross responded, as he scanned the aerometre and promptly pulled open the valve, preparatory to descending.

"Placing my hand out over the side of the car the rush of cold air against my downturned palm indicated that we were again swiftly journeying earthward. Soon we were enveloped in the fog of the cloudbank for a minute or two, and then emerged with the distant earth in view. The glance at it from my perch there away up near the clouds only increased my nervousness.

"'Look up! look up!' exclaimed the aeronaut, 'or you'll lose your nerve.'

"A glance downward when descending with the parachute might, I knew, turn my hair white or bring on a stroke of paralysis, as it had done in the case of some other men.

"'Twenty-five hundred feet from here to the ground,' exclaimed the smiling Norcross. 'Get ready.'

"He then bound round my body under the arms a stout rope, the other end of which was secured to the trapeze bar in my hand, which bar in turn was attached to the parachute that hung at the bottom of the car.

"It was now rapidly approaching the time when I should make the leap of my life, and, grasping the guy ropes of the car, I stood upon the seat in readiness, while Norcross gave me his final instructions.

"'Leap as far out into the air as possible, and the tightening of the trapeze line will release the parachute, which will open its 15-ft. spread in a second or two,' he said; 'then all you've got to do is to look up and hang on.'

"'Twelve hundred feet,' shouted Norcross. I tightened my grasp on the trapeze bar, looked steadfastly upward, and awaited the word to leap. It was the most trying time of my life, but I was determined to make the jump.

"'Go!' suddenly exclaimed the aeronaut. Closing my eyes, I made a great leap out into space, and could feel myself rapidly shooting downward. Then the trapeze line tautened with a slight jerk that indicated the release of the closed parachute, and I looked up just in time to catch a flee-

ing glimpse of Norcross's smiling face peering over the side of the car far above me. But the parachute did not open. The seconds passed into a minute, and then into three, four, five minutes. Would the parachute never open? Must I be dashed to death on the ground 1,000 ft. below?

"Suddenly there came a sharp click from above, and my speed perceptibly slackened. Ah, the parachute had opened! My life was saved! With an intense feeling of satisfaction I felt myself deliberately descending, and, looking about, though not directly beneath me, took in the scenic beauties of my journey on every hand. But there came over me a grave fear. Suppose in my descent I should strike the top of a church steeple or one of the many chimneys with which that section of the country abounded. Common sense, however, came to my rescue.

"Norcross, I felt convinced, knew his business, and had the balloon directly over a clear space when I made the leap, so where was the sense of such foolish fears and baseless apprehensions?

"Finally I mustered courage and looked directly below. The earth was approaching rapidly. The fences, trees, houses, and barns became more and more clearly outlined, and roofs seemed to rise directly out of the ground. Horses, cattle, and men rose rapidly from pigmy proportions to their normal size. I saw that I would land in a broad pasture field about half a mile from where we had ascended, and there was not a chimney, roof, or tree within 100 yds. There was nothing to fear.

"I saw a crowd of men and boys hastening toward the field to welcome me. Then, a few seconds afterward, to my delight, my feet struck the ground, and the most thrilling journey of my life was ended.

"Calmly I folded the parachute and then looked up for the balloon. I saw it gracefully sinking to the earth in an adjoining field, and a few minutes later had the satisfaction of receiving the hearty congratulations of the aeronaut, who told me, to my great surprise, that the parachute opened within three seconds after I leaped."

EFFICIENCY OF WINDMILLS.

In a paper by Mr. John A. Griffiths, published in the Minutes of Proceedings of the Institution of Civil Engineers, the results of some experiments on windmill efficiency are given. The mills in question were used for pumping water in Queensland. The first has a conical sail-wheel of 223 sq. ft. area, with a reefing vane, and operates a pump having a plunger 5 in. in diameter by 6¼ in. stroke. With a wind velocity of 4.3 miles per hour, this mill developed .018 H.P., which was increased to .98 H.P. when the wind rose to 7 miles per hour. Another mill, with a "solid" wheel 11 ft. in diameter, gave .011 H.P. effective with a wind velocity of 5.8 miles per hour, and .025 H.P. with a wind velocity of 6 5 miles per hour. A third "solid" wheel 16 ft. in diameter, fitted with an automatic rudder, gave .024 H.P. with a 6-mile wind. The fourth mill has a folding sail 14.16 ft in diameter, and gave .065 H.P. with a 7-mile wind; and another similar but smaller mill, having a wheel 10.16 ft. in diameter, gave .028 H.P. effective with an 8-mile wind. The sixth wheel has a 9.83 ft. turbine wheel, and gave .012 H.P. effective with a 6-mile wind. As a general result, the best efficiency of the mills was about 12 per cent. of the total energy in the wind.

PHOTOGRAPHS FROM A KITE.

Mr. William A. Eddy, the indefatigable kite-flyer of Bayonne, N. J., has succeeded in making photographs with a camera attached to the string of his tandem tailless kite apparatus. The method of doing this was fully described in an article written by Mr. Eddy and published in the New York *Herald* of June 16. The shutter of the camera was "snapped" by a string attached to it; but this method was very uncertain. Of this method of making pictures, Mr. Eddy says:

"It seems to me that the kite string camera will be useful, when improved, to map the position of an enemy in time of war, when strong winds would blow a captive balloon down sideways and endanger the photographer. By means of the kite string it is now possible to look from a great height without danger to life and without the expense of a balloon ascension. It is a characteristic of all first experiments that many improvements are to be made, many difficulties to be overcome, and the experiments will continue with every present indication that successful pictures will be taken during the present summer. If we can practically place the human eye at the height of the Eiffel Tower it will seem to foreshadow the advent of aerial navigation, when men will travel aloft, where Professor S. P. Langley has already sent an automatic motor machine without human guidance."

BORNSTEIN'S WIND-MEASURER.

In a paper describing several apparatuses for measuring the pressure of wind, the author states that the one which gives the most accurate results is that of Professor Bornstein. This apparatus consists of a light, hollow ball fixed on the top of an axle, the bottom end of which rests in a ball-and-socket joint. An arm is fixed to the joint, which extends below to the measurement-room, and by means of a good transport mechanism registers the wind pressure on a strip of paper moved by clockwork. In addition a side-lever is provided, which by means of balance weights will denote the absolute pressure at any required time.

The author states that most appliances for obtaining the wind-pressure register only the speed, from which the pressure is calculated, the results obtained giving varying amounts, according to the formula used; but with Bornstein's apparatus the pressure is registered directly on the paper, and it also registers with great accuracy the pressure of single gusts of wind. The chief disadvantage of this apparatus lies in the fact that the same instrument will not register with sufficient accuracy a pressure of a few grams and one of several kilogrammes, and it is thus necessary to have two or more appliances at the same place.

The paper is accompanied by a plate containing sketches of Bornstein's apparatus and several other wind measurers.—*Verhandlungen des Vereins für Eisenbahnkunde*, 1894.

A LILIENTHAL APPARATUS IN DUBLIN.

Professor Fitzgerald, of Trinity College, Dublin, lately purchased from Herr Lilienthal one of his aerial soaring machines, to be exhibited as one of the attractions at a forthcoming bazaar in aid of a hospital.

The machine consists of an aeroplane about 24 ft. across by 8 ft. in breadth, with a tail composed of four small fans, and is intended to glide downward against the wind when mounted and directed by an operator, in the same way as in the experiments of Herr Lilienthal, which are probably well known to our readers.

The first experiments occurred in the college grounds on April 2, in the presence of many students and spectators. They are thus described by the *Dublin Telegraph* of April 3, 1895:

"It was a quarter past one exactly when the professor, doffing his coat, prepared for his task. The preliminaries were simple. Eager volunteers at the word of command raised from the ground the machine—which is 24 ft. long and 8 ft. wide—and placed it *in situ*—that is, they gently lowered it over the professor's head and shoulders, till the same appeared through a square aperture in the centre. The professor then seemed to be wearing at his waist an enormous white skirt,* of the most advanced ballet artiste type, fitting admirably, while the peculiar-shaped tail suggested an exaggerated 'dress improver.' There was a fairly strong breeze on, and the onlookers expected an instant manifestation. This, however, did not come. The professor seemed for a minute or two at a loss; but at last, realizing that something was expected, he made a short run with the machine, but it did not soar, or do anything save stick close to its occupant. The experiment was repeated with like result. Needless to say there was much disappointment, especially among the uninvited guests outside the college wall, who were prepared to cheer loudly if the professor rose in the air.

"After a little delay a long table, 3 ft. high, was got by two college porters, and with the aid of the bystanders Professor Fitzgerald mounted and made ready for another try. This was effected by his running along the table to the end, and jumping off, machine-clad as before, when he seemed to 'land' below, on his legs, with about the same force as if unencumbered.

"Undeterred by these failures another essay was made. This time cords were attached to the framework, and several parties pulled it forward, till the professor, keeping pace, had to run; and, sure enough, after 20 or 30 yds. had been traversed, the machine 'lifted' about 2 ft. from the ground, and, sustained by a rather brisk wind, carried itself and the experimentalist at that very moderate altitude for a short—in truth, a very short—distance.

"However, the outside spectators, who wanted something of a show for their expenditure of time and patience, were satisfied and applauded vigorously. A repetition of the proc-

* Like the Saracen who experimented at Constantinople in 1178.

ess produced a similar effect, and when Professor Fitzgerald disencumbered himself of the machine, it was felt all round that it had a certain potency of 'soaring' when the conditions were more favorable for the display."

A further experiment was made on April 5, by which time a sloping platform about 2 ft. wide had been erected, leading from the ground to the parapet of a pavilion. Professor Fitzgerald, clothed in the machine, backed up the platform for a short distance, and then ran down to the ground, but did not gain sufficient speed to soar, although the wind was favorable. Again and again the experiment was repeated, each time with a longer run, but without success, as the platform was evidently too narrow to admit of rapid and unobstructed movement. Two enthusiastic students had each a try, but little if any work was obtained. Finally, a small disaster brought the day's proceedings to a close. While one of the students was placing himself in position on the sloping plank and fixing the machine at a certain angle, a gust of wind tipped it up, and the whole business, man and machine, fell over inside the pavilion rails, scattering a group of onlookers, who were quite unprepared for the incident, and slightly damaging the machine.

This doubtless was soon repaired and the experiments renewed, although accounts of the same have not yet come to hand. It is very evident that, as Herr Lilienthal has all along insisted, it requires a good deal of skill and practice to learn to manage one of these machines in so yielding and fluctuating a medium as wind.

RECENT AERONAUTICAL PUBLICATIONS.

A MANUAL FOR THE PRACTICAL USE OF AVIATORS AND AERONAUTS. (German.) Published by W. H. Kühl, Berlin, 1895. 198 pp.

Nothing marks better the recent rapid advance in aeronautics, and the growing faith that practical success is not afar off, than the present publication, in German, of a pocket book for practitioners and students of this inchoate art. This book has been edited by Captain H. W. L. Moedebeck, of the German Artillery, assisted by Captain H. Hoernes, Dr. V. Kremser, Engineer O. Lilienthal, Dr. A. Miettre, and Professor K. Müllenhoff—all of them experts in various specialties.

The book seems to have been prepared with great care. It contains numerous tables, blank forms, and formulas, and 17 illustrations. The following is a brief analysis of its contents:

Chapter I., by Dr. Kremser, *Physics of the Atmosphere.* A very good *résumé* of aerostatics, of effects of temperatures, moisture, clouds, winds, barometric gradients. The general circulation of the atmosphere. Annual and bi-annual changes in air pressures, temperatures, and moisture. Also the electrical and optical phenomena of the atmosphere.

Chapter II., by Captain Moedebeck, *Balloon Construction.* The shape and lifting power, with either hydrogen or illuminating gas. The materials, their strength and weight. The cutting, sewing, varnishing of ordinary balloons. Pasting together of balloons made of gold-beater's skin, both by the English and the French methods. Concerning valves, netting, cars, anchors. Also captive balloons and aeroplane balloons. Warm-air balloons, with formulæ for each.

Chapter III., by Professor Müllenhoff, *Chemistry of Aeronautical Gases.* The general laws, the production and cost of hydrogen, of illuminating gas, and ammoniacal gas. It is mentioned that the latter will not answer aeronautical purposes, although it is cheap and light, in consequence of its action on the varnish, but no notice is taken of recent improvements in the production of water gas, whereby hydrogen is very cheaply produced by a process which almost entirely eliminates carbon oxide.

Chapter IV., by Captain Moedebeck, *Balloon Trips.* Air displacement and levity. Factors which limit the height attained. Extended, high, distant, or quick journeys. Trips with a predetermined terminal point, and trips with the drag-rope. Landings and precautions to take. Ballast to be used.

Chapter V., by Dr. Miethe, *Balloon Photography.* The choice of apparatus and processes to be employed.

Chapter VI., by Dr. Kremser, *Observations in Balloons.* Meteorological and other scientific principles. The instruments and their use: clocks, aneroids, mercurial barometers, psychometers, compass, maps, dry and wet bulb thermometers, together with tabular blanks, with a note on the construction of diagrams by Captain Moedebeck.

Chapter VII., by Dr. Müllenhoff, *Bird Flight.* After glancing at the literature on the subject, in the whole of which, it is said, there are no really reliable data before those published by Professor Marey, the laws and modes of flight are laid down, as observed in rowing, gliding, hovering, sailing, and circling flight, which last is said to be very difficult to explain. Then a classification is given of flying creatures, based on peculiarities of wings, and also the strength of muscles and probable work done in flight.

Chapter VIII., by O. Lilienthal, *Artificial Flight.* We would give this chapter in full, had not the editor reserved the right of translation, reprinting even with a statement of the source not being permitted.

Herr Lilienthal gives his reasons for believing that "individual flight"—*i.e.*, that of one man alone—is the proper way to begin, so as to limit the size of the apparatus and learn the tricks of the wind. Then he gives a *résumé* of the facts brought out by his experiments, concerning air reactions on wings provided with a slightly arched profile, with diagrams of the resolution of forces and a table of "normal and tangential" pressures at various angles of incidence. These diagrams and table present the peculiarity that the pressure is said not to be normal to the surface, against the belief of all physicists hitherto, that Herr Lilienthal shows these forces as applied at the centre of figure, instead of at the centre of pressure, and that he deduces the force from what he calls the normal and the tangential pressures, instead of first ascertaining the total pressure and then resolving it into the "lift" and "drift" consequent upon the angle of incidence, as has hitherto been done for planes.

The most remarkable results, however, appear from the table, which shows, for arched surfaces, that at angles of incidence exceeding 3°, the resisting component of the air pressure, the "drift" becomes negative, and acts as a propelling component, which at an angle of 15° becomes equal to one-twelfth of the lift, and does not disappear entirely until 30° is reached—a sort of "aspiration," as it were. This is Herr Lilienthal's great discovery, and holds out good hope that man may succeed in sailing the air; for he says that "A current of air rising at an upward trend of 3° (5 per cent.) above the horizontal, acts upon a horizontal arched surface with a strong uplift, without driving it back, and is the principal reason for the soaring of birds."

After giving a numerical example of the method of calculating the forces by his formula, Herr Lilienthal gives directions for practical flight, a sketch of his apparatus and experiments, and in an advertisement in the back of the book he offers to sell duplicates of his apparatus to amateurs.

Chapter IX. is in two sections: 1. *Dynamic Air-Ships*, by Captain Hermes. This consists of general considerations, formulæ, methods for determining laws of air resistance, friction, etc., dividing the various kinds of dynamic air-ships into five classes: 1. Wave line; 2. Aeroplanes; 3. Sail wheel machines; 4. Screws; and 5. Beating wings. Calculations of strength and power required. Influence of the wind, gusts, etc. The second section is 2. *Navigable Balloons*, by Captain Moedebeck, giving the results of various experiments and various failures. The proper construction of such balloons, position of the screw, choice of motors; steam, electricity, gas-engines, and petroleum-engines.

Chapter X., by Captain Moedebeck, *Military Aeronautics.* Contains a sketch of what has been done in the way of military balloons in every country on the globe; the different uses to which they may be put, and their vulnerability. Of course the latest improvements are not described, these being preserved as State secrets, to serve in case of war; but the reader will be surprised to learn how many governments now maintain aeronautical establishments, and how general the use of balloons, captive or free, is likely to become in military operations.

In addition to these practical tables, notes, and essays, this little book, which is 6 × 4¼ in. and ½ in. thick, contains tables of weights and measures, specific gravities, foreign coins, postal and telegraph rates, differences in local time, a lexicon of aeronautical terms in German, French, and English, a list of aeronautical societies, and another of dealers in aeronautical supplies, as well as an inset of 40 pages ruled in blank, in the front part, upon which to enter notes of aerial journeys. At the end of the book is the bibliographical catalogue of the publisher, W. H. Kühl, Jägerstr. 73, Berlin, who makes a specialty of aeronautical publications.

The book is exceedingly well gotten up, contains the gist of what has hitherto been published of value upon the subject, and although it addresses but a limited number of readers, it is much to be desired that an edition shall be published in English, either in Great Britain or in this country.

AERONAUTICS. An abridgment of aeronautical specifications filed at the British Patent Office from A.D. 1815 to A.D. 1891. By Brewer and Alexander. 8¼ × 4¼ in., 160 pp.; illustrated; price, $2.50.